Table 5.2. Course specification

Study program : Advanced Data Analytics in Business
Course title: Academic Writing
Teachers: Dejan Brcanov, Stojanka Dakić
Status of the course: Elective
Number of ECTS: 7
Condition: No
Goal of the course The goal of the course is to develop student's ability to write research papers and other academic texts.
Learning outcome Student understands research principles, knows how to write research questions, hypothesis and objectives, design adequate literature review, acquire the ability to access and extract relevant information from relevant data sources, write an effective research proposal.
Content of the course *Theoretical part* *Week 1.: Introduction in academic writing and research* *Week 2: Definition of research questions, hypothesis and research goals.* *Week 3-4: Literature: choice, critical thinking developing, citations and referencing styles* *Week 5-6: Formulating research design* *Week 7-8: Data sources: access to data bases and developing questionnaires* *Week 9-11: Analysing quantitative data* *Week 12: Analysing qualitative data* *Week 13-15: Paper writing and presenting* *Practical part* *Discussions on course subjects, individual preparation for master thesis.*
Literature 1. Bryman, A. & Bell, E. (2011). Business Research Methods - Third Edition. Oxford University Press Inc., New York, USA. 2. Saunders, M., Lewis, P., Thornhill, A. (2007). Research Methods for Business Students - 4th Edition. Pearson Education, Harlow, England. 3. Salkind, N.J. (2018). Exploring research - 9th Edition. Pearson Education, Harlow, England. **4.** Swales, J.M. & Feak, C.B. (2012). Academic writing for graduate students: essential tasks and skills - 3rd Edition.The University of Michigan Press, USA.

Number of hours of active teaching	**Theoretical teaching: 2**	**Practical teaching: 2**

Teaching methods Lectures, discussions, paper writing on teaching subjects.

Assessment (maximum number of points 100)			
Pre-exam obligations	Points	**Final exam**	Points
Activities during semester	**5**	Written exam	**15**
Practical part	**5**	Oral exam	**15**
Colloquium	**20**	.....	
Seminar paper	**40**		

Table 5.2. Course specification

Study program : Advanced Data Analytics in Business
Course title: Advanced Analytics with SPSS
Teachers: Stojanka Dakić, Dejan Brcanov
Status of the course: Elective
Number of ECTS: 7
Condition: None
Goal of the course The main goal of this course is to familiarize students with the power and functionality of IBM SPSS Statistics as a data analysis tool and to cover standard exploratory statistical analysis of data. This course will introduce basic methods for data import, data management, graphics, basic and advanced statistical analysis by using the SPSS software package.
Learning outcome Students will develop the fundamental skills needed to prepare data sets for analysis, and to conduct statistical analyses and report those analyses. At the completion of this course, students will be able to: • Prepare and manipulate datasets for analysis in SPSS. • Conduct simple descriptive and graphic analyses of data in SPSS. • Conduct advance statistical analyses of data in SPSS. • Prepare a report with a summary of analyses conducted in SPSS.
Content of the course *Theoretical part* *1. week: Introduction to SPSS* *2. – 3. week: Basic Statistical Concepts* *4. – 5. week: Descriptive statistics* *6. week: Comparing Means: One or Two Samples t-Tests* *7. week: Comparing Means: Analysis of Variance* *8. week: Chi-Square Test of Independence for Discrete Data* *9. week: Correlation Analysis* *10. – 11. week: Multiple Regression* *12. week: Logistic Regression* *13. week: Data Reduction and Scale Reliability: Factor Analysis* *14. – 15. week: Advanced Data Handling in SPSS* *Practical part* *Work on practical tasks, helping students with writing of seminar paper.*
Literature 1. Gaur, A., Gaur, S. (2009) Statistical Methods for Practice and Research. A guide to data analysis using SPSS (second editon). SAGE Publicaton, Inc, USA. 2. Field, A., (2009) Discovering Statistics Using SPSS - third edition. SAGE Publicaton, Inc, USA. 3. Landau, S., Everitt, B.S. (2004) A Handbook of Statistical Analyses Using SPSS. Chapman & Hall/CRC Press LLC, Florida USA.

Number of hours of active teaching	**Theoretical teaching: 2**	**Practical teaching: 2**

Teaching methods Teaching and exercises will be done in computer labs using multimedia presentations and SPSS software package. Teaching takes place through lectures, exercises and independent work. Proof of knowledge is done through writting seminar paper, colloquiums, written and oral exams.
Assessment (maximum number of points 100)

Pre-exam obligations	Points	**Final exam**	Points

Activities during semester	**5**	Written exam	**20**
Practical part		Oral exam	**15**
Colloquium (2 colloquium)	**40**	.....	
Seminar paper	**20**		

Table 5.2. Course specification

Study program: Advanced Data Analytics in Business

Course title: Advanced Econometrics

Teachers: Boris Radovanov

Status of the course: Elective

Number of ECTS: 7

Condition: None

Goal of the course

Introduction of students with different methods of advanced econometric analysis, topics and methods of modern econometric analysis used in advanced data analytics and data science, training for independent empirical research. New knowledge in the field of assessment, testing and interpretation of econometric models of different kinds with use of econometric software. As software support, we are using GRETLS, EVIEWS and R language.

Learning outcome

Student is capable to identify the economic problem, to define adequate sample and to choose the best econometric model and implementing it with use of econometric software, and on the basis of obtained results to make conclusions and interpret the results.

Content of the course

Theoretical part

1-3. Repetitorium of basic topics in econometrics

3-4. Non-linear regression functions

5. Panel models

6. Instrumental variables

7. Experiments and quasi experiments

8. Binomial logistic regression

9. Multinomial logistic regression

10. Logistic regression with ranks

11. Models with counting data

12. Survival analysis

13. Spatial analysis

14. Tobit and Heckit models

15. Time series analysis

Practical part

Work on practical tasks, writing of seminar paper on the basis of theoretical topics and learning econometric software in computer lab.

Literature

1. Stock, J. & Watson, M. (2015). Introduction to Econometrics, 3rd edition. Pearson Education, Inc.
2. G.S. Maddala: Introduction to econometrics, John Wiley & Sons, 3rd edition, 2001.
3. W.H.Greene: Econometric analysis, 5th ed., Prentice Hall, 2003.
4. Baltagi, B. H., Econometrics, Springer, 2002
5. Bingham, N.H., Fry, J.M., Regression (Linear models in Statistics), Springer, 2010.

Number of hours of active teaching	**Theoretical teaching: 2**	**Practical teaching: 2**

Teaching methods

Lectures and exercises are conducted in the computer laboratory.

Assessment (maximum number of points 100)

Pre-exam obligations	Points	**Final exam**	Points
Activities during semester	**5**	Written exam	**15**
Practical part	**5**	Oral exam	**15**
Colloquium (2 colloquiums times 20 points)	**40**	.....	
Seminar paper	**20**		

Table 5.2. Course specification

Study program : Advanced Data Analytics in Business			
Course title: Big Data Fundamentals			
Teachers: Boris Radovanov, Aleksandar Kupusinac, Dragan Stojić			
Status of the course: Obligatory			
Number of ECTS: 7			
Condition: No			
Goal of the course To provide the students with basic knowledge of big data: big data characteristics, storing, cleansing and analysing big data, with the emphasis on predictive and prescriptive analytics.			
Learning outcome Students will be able to apply the methods of data collection and data analytics to solve business related problems in support of business decision making. Students will develop competencies necessary to use related softwaretools to perform data collection, cleansing and analytics.			
Content of the course *Theoretical part* 1-2. Introduction to Course 3. Relational databases 4. Structural and non-structural data 5-6. Data cleansing 7-8. Data visualisation 9. Descriptive statistics and 10. Correlation 11-12. Association analysis and 13. Cluster analysis 14-15. Principles of classification *Practical part* Work on case studies based on real-world data using computer laboratory.			
Literature 1. Provost, F., Fawcett, T.(2013). Data Science for Business, ISBN 978-1449361327 2. Erl, T., Khattak, W., Buhler, P.(2015). Big Data Fundamentals: Concepts, Drivers & Techniques.			
Number of hours of active teaching	**Theoretical teaching: 2**	**Practical teaching: 3**	
Teaching methods Teaching will be done in classrooms, computer labs using appropriate teaching resources (multimedia presentations, software packages, etc.). Teaching takes place through lectures, exercises and independent work. Proof of knowledge is done through written and oral exams.			
Assessment (maximum number of points 100)			
Pre-exam obligations	Points	**Final exam**	Points
Activities during semester	**5**	Written exam	**15**
Practical part	**5**	Oral exam	**15**
Colloquium	**40**	.....	
Seminar paper	**20**		

Table 5.2. Course specification
Business & Decision Modelling

Study program : Advanced Data Analytics in Business

Course title: Business & Decision Modelling

Teachers: Sedlak Otilija, Marcikić Horvat Aleksandra, Papatanasiu Jason

Status of the course: elective

Number of ECTS: 7

Condition: No

Goal of the course

The aim of this course is to provide students with the necessary knowledge regarding basic concepts and methods of decision-making in different areas of the economy by applying quantitative methods. Knowledge acquired in this area should point the need for certain methods in the field of economics, in order to make effective decisions.

Learning outcome

Students' abilities to successfully use the knowledge for recognition of different economic connections in order to provide support in the process of making economic decisions: optimizing business decisions; planning and optimization of inventories and costs; modeling of problems with non-fulfillment of traditional assumptions, recognition and formulation of the decision-making process.

Content of the course

Theoretical part

1. *Quantitative research in economics and economic models;*
2. *Significance of quantitative methods in analysis and planning;*
3. *Operational Research and Linear Programming;*
4. *Formulation and application of LP models;*
5. *The solution of the primary and dual model;*
6. *Integer programming;*
7. *Nonlinear programming;*
8. *Specific linear models;*
9. *Transportation problems;*
10. *Problem of async;*
11. *Network models;*
12. *PERT / CPM;*
13. *Maximum flow problems;*
14. *Game Theory;*
15. *Simulation.*

Practical part

Computer solution of OR problems with the structured packages: LINDO / LINGO, EXCEL. Practical part of teaching will be in computer labs for solving and analyzing the solutions. Applications of mathematical methods and models in decision making in business.

Literature

1. Winston, W.L., Practical Management Science, South-Western, Cengage learning, 2012.
2. Winston, W.L., Operations Research, Applications and Algorithms, Duxbury Press, Belmont, 1994.
3. Anderson, D. R., Sweeney, D. J., Williams, T. A., Camm, J. D., Cochran, J. J., Fray, M. J., Ohlmann, J. W., Quantitative Methods for Business, South-Western, Cengage Learning, 2013.
4. Wisniewski, M., Quantitative Methods for Decision Makers, Pearson Education Limited, 2016.
5. Render, B, Quantitative Analysis for Management, Pearson Education, 2008.

Number of hours of active teaching	**Theoretical teaching: 2**	**Practical teaching: 2**

Teaching methods

Teaching will be done in classrooms, computer labs using appropriate teaching resources (multimedia presentations, software packages, etc.). Teaching takes place through lectures, exercises and independent work. Proof of knowledge is done through written and oral exams.

Assessment (maximum number of points 100)

Pre-exam obligations	Points	**Final exam**	Points
Activities during semester	5	Written exam	15
Practical part	5	Oral exam	15

Colloquium	2 times 20 points	.....	
Seminar paper	20		

Table 5.2. Course specification

Study program : Advanced Data Analytics in Business

Course title: Business Cases

Teachers: Aleksandra Marcikic Horvat, Otilija Sedlak

Status of the course: Obligatory

Number of ECTS: 7

Condition: No

Goal of the course

The aim of this course is to provide students with the necessary knowledge regarding practical application of data science. The idea is to support problem-based learning using real-life examples of practical application of data science in various areas of business. The course also includes research-based case studies that address current topics and critical issues in data science.

Learning outcome

Ability of students to recognize different areas of application of methods and models of data science in practice, in order to provide support in economic decision-making processes: making financial decisions by applying data science; making marketing decisions by applying data science; decision making process management by applying data science; decision making in health management using data science; decision making in agricultural production using data science.

Content of the course

Theoretical part

1. *Introduction to the practical application of data science in business.*
2. *Development of critical thinking about data and modeling.*
3. *Optimization models.*
4. *Multicriteria decision making.*
5. *Multi-attribute decision making.*
6. *Decision making in conditions of uncertainty.*
7. *Decision making in risk conditions.*
8. *Practical examples of the application of data science in finance.*
9. *Practical examples of the application of data science in supply chain management.*
10. *Practical examples of the application of data science in inventory management.*
11. *Practical examples of the application of data science in marketing.*
12. *Practical examples of application of data science in business informatics.*
13. *Practical examples of the application of data science in the management of industrial processes.*
14. *Practical examples of the application of data science in health management.*
15. *Practical examples of the application of data science in agriculture.*

Practical part

Computer solution of case studies with the structured packages: LINDO / LINGO, EXCEL. Practical part of teaching will be in computer labs for solving and analyzing the solutions. Applications of mathematical methods and models in decision making in business.

Literature

1. Kaldero, N., Data Science for Executives, Lioncrest Publishing, 2018
2. Wisniewski, M., Quantitative Methods for Decision Makers, Pearson Education Limited, 2016.
3. Foreman, J. Data Smart: Using Data Science to Transform Information into Insight, John Wiley & Sons, Indianapolis, USA, 2014
4. Winston, W.L., Practical Management Science, South-Western, Cengage learning, 2012.

Number of hours of active teaching	**Theoretical teaching:2**	**Practical teaching:3**

Teaching methods

Teaching will be done in classrooms, computer labs using appropriate teaching resources (multimedia presentations, software packages, etc.). Teaching takes place through lectures, exercises and independent work. Proof of knowledge is done through written and oral exams.

Assessment (maximum number of points 100)

Pre-exam obligations	Points	**Final exam**	Points
Activities during semester	5	Written exam	*15*
Practical part	5	Oral exam	*15*
Colloquiums (2 times 20 points)	40	.....	
Seminar paper	20		

Table 5.2. Course specification

Study program : Advanced Data Analytics in Business			
Course title: Deep Learning			
Teachers: Nebojša Gvozdenović, Olivera Grljević, Ronald Hohrajter			
Status of the course: Elective			
Number of ECTS: 7			
Condition: Basic python programming			
Goal of the course Modern data analytics in business increasingly relies on machine learning techniques, i.e. quality business decisions are made after data being processed by machine learning methods. Having this in mind, machine learning and especially the segment of deep learning in business analysis represents an important apparatus of modern economic sciences, and the subject itself provides the basis for successfully mastering their basics. Particular attention is paid to the connection between theory and business, as well as the application of methods through computer work. The aim of the course for the student is to learn the basics of deep neural networks, to understand how to apply and develop a neural network and lead projects in the field of machine learning.			
Learning outcome By mastering the content of the course, students will be able to identify problems from business analysis that can be solved by machine learning techniques. The problems will come from a case study and will be equivalent to problems from practice. Theoretical and practical knowledge acquired through this course will enable them to recognize the nature of the problem, to recognize models and techniques by which the problem is solved and to look for appropriate tools. They will be able to prepare data for the model, translate the model into a form that existing tools can handle, select algorithms to solve, solve the problem and interpret the results, and propose decisions based on the results. Students will also be able to develop different neural network architectures, such as CNN, RNN, LSTM in Python programming language, to understand key parameters of neural network architecture, and to realize photo classification and perform textual data analysis using neural networks.			
Content of the course *Theory classes* *1-3. Fundamentals of machine learning;* *4-5. Applications of different types of neural networks;* *6-8. Optimization of parameters and training of neural networks;* *9-10. Basics of working in a programming language;* *11. Data transformation;* *12-13. Projects in Python programming language;* *14-15. Modeling.* *Practice and Exercises* *Preparation of assignments and seminar work in the areas listed in the theory classes and mastering the Python programming language and selected libraries for deep neural networks (such as Keras, Tenserflow) in the computer lab*			
Literature **Литература** 1. Ian Goodfellow, Yoshua Bengio, Aaron Courville. (2016). Deep Learning (Adaptive Computation and Machine Learning series). The MIT Press. 2. Andrew Ng. (2018). Machine Learning Yearning - Technical strategy for AI engineers, in the era of deep learning. deeplearning.ai 3. Francois Chollet. (2017). Deep Learning with Python. Manning Publications. 4. V Kishore Ayyadevara. (2019). Neural Networks with Keras Cookbook: Over 70 recipes leveraging deep learning techniques across image, text, audio, and game bots. Packt Publishing. 5. Richard S. Sutton, Andrew G. Barto. (2018). Reinforcement Learning: An Introduction (Adaptive Computation and Machine Learning series) second edition. A Bradford Book.			
Number of hours of active teaching	**Theoretical teaching:2**	**Practical teaching:2**	
Teaching methods Lecturing, exercices, discussions, case study analysis in a computer lab.			
Assessment (maximum number of points 100)			
Pre-exam obligations	Points	**Final exam**	Points

Activities during semester	**5**	Written exam	
Practical part	**5**	Oral exam	**30**
Colloquium (2 times 20 points)	**40**	.....	
Seminar paper	**20**		

Table 5.2. Course specification

Study program : Advanced Data Analytics in Business			
Course title: Designing communication of results			
Teachers: Aleksandar Kupusinac, Luca Gnan			
Status of the course: Elective			
Number of ECTS: 7			
Condition: None			
Goal of the course The goal of the course it to teach students to set of techniques and tools for extraction and transformation or raw data into meaningful and useful information for business analytics. Also, the goal is to develop ethical competences related to data collection, storing, dissemination and analysis.			
Learning outcome Students know to implement tools for extraction and transformation of raw data and to identify and evaluate ethical impact in data driven organisation. Students know to implement techniques for protection of privacy, ethical distribution of data and minimise negative consequences in data driven organisation.			
Content of the course *1. Theoretical part* *2. Definition of business intelligence* *3. Modelling* *4. Data reservation* *5. Big data* *6. Data description and visualisation* *7. Techniques of data visualisation* *8. Decision systems* *9. Overview of ethical questions in the data based organization* *10. Development of equality framework* *11. Data ethics techniques* *12. Discrimination and algorithms* *13. Privacy and monitoring* *14. Security* *15. Data protection methods* *Practical part* *Case studies, work in computer lab.*			
Literature 1. Bentley, D.(2017). Business Inteligence and Analytics. Library press, New York, USA. 2. Grossmann, W., & Rinderle-Ma, S. (2015). Fundamentals of Business Intelligence. Data-Centric Systems and Applications.Springer, Berlin. 3. Richterich, A.(2018). The Big Data Agenda - Data Ethics and Critical Data Studies. University of Westminster, London, UK. 4. Muntean, M.(2012). Theory and Practice of Business Reporting. Munich Personal RePEc Archive, Paper No. 41359. 5. Withee, K.(2010). Microsoft Business Intelligence for Dummies.Wiley Publishing, Indianapolis, USA.			
Number of hours of active teaching	**Theoretical teaching: 2**	**Practical teaching: 2**	
Teaching methods All lectures are conducted in computer lab.			
Assessment (maximum number of points 100)			
Pre-exam obligations	Points	**Final exam**	Points
Activities during semester	**5**	Written exam	**15**
Practical part	**5**	Oral exam	**15**
Colloquiums (2 times 20)	**40**	.....	
Seminar paper	**20**		

Table 5.2. Course specification

Study program : Advanced Data Analytics in Business			
Course title: Digital marketing			
Teachers: Aleksandar Grubor			
Status of the course: Elective			
Number of ECTS: 7			
Condition: None			
Goal of the course The objective of the course is to train students for the realization of the steps in the marketing management process in the field of digital marketing.			
Learning outcome Based on the acquired knowledge, students will be able to manage the digital marketing process. It is helpful in the proper implementation of various digital marketing activities in various areas of their application.			
Content of the course *Theoretical part* *1. week: Defining digital marketing* *2. week: Digital marketing myopia, digitalization and marketing paradigm* *3. week: Digital marketing and changing the marketing paradigm* *4. week: Digital marketing research* *5. week: Digital marketing environment* *6. week: Targeted marketing* *7. week: Market segmentation and selection of target market* *8. week: Creating value* *9. week: Positioning and differentiation of digital values and experiences* *10. week: Marketing mix in the digital environment* *11. week: Product / service in a digital environment* *12. week: Determining and differentiating online prices* *13. week: Distribution channels in the digital environment* *14. week: Digital marketing communication* *15. week: Organization, implementation and control of digital marketing activities* *Practical part* *Realization of digital marketing research, selection of elements of strategy and tactics of digital marketing.*			
Literature 1. Rakić, B., Rakić, M. (2015). Digitalni marketing: integrisani pristup digitalnim marketinškim aktivnostima. Zavod za udžbenike i nastavna sredstva: Beograd **2.** Čefi, D., Smit, P.R. (2018). Digitalni marketing: planiranje i optimizacije. Fakultet za medije i komunikacije: Beograd (chosen parts)			
Number of hours of active teaching	**Theoretical teaching: 2**	**Practical teaching: 2**	
Teaching methods Lectures, excercises, consultations, discussions, using appropriate tools			
Assessment (maximum number of points 100)			
Pre-exam obligations	Points	**Final exam**	Points
Activities during semester	**5**	Written exam	
Practical part		Oral exam	**40**
Colloquium (2 times by 20 points)	**40**	.....	
Seminar paper	**15**		

Table 5.2. Course specification

Study program : Advanced Data Analytics in Business			
Course title: Financial Analytics			
Teachers: Boris Radovanov, Laslo Šereš			
Status of the course: Elective			
Number of ECTS: 7			
Condition: No			
Goal of the course The goal of the course is to provide students a different view on the financial data and an in-depth financial knowledge approach in order to improve overall financial business performances.			
Learning outcome Students are able to implement a large set of financial models. Through examples, they learn how to obtain raw data, perform the analysis and generate an output properely. Therefore, students learn how to answer specific business questions and forecast possible future scenarios using real-world data available online.			
Content of the course *Theoretical part* *1-2. Stock market introduction* *3-4. Analytical thinking* *5-6. Financial statistics* *7-8. Risk measurement* *9-10. Time series analysis* *11. Forecasting techniques* *12-13. Simulation of trading strategies* *14-15. Measuring portfolio performances* *Practical part* *Work on case studies based on real-world data using computer laboratory.*			
Literature 1. Bennet, M. & Hugen, D. (2016). Financial Analytics with R: Building a Laptop Laboratory for Data Science. Cambridge University Press. 2. Mitra, G. & Mitra, L. (2012). A Handbook of News Analytics in Finance. John Wiley & Sons Ltd, Chichester, UK. 3. Williams, E. & Dobelman, J. (2017). Quantitative Financial Analytics: The Path to Investment Profits. World Scientific, Singapore. **4.** Ang, C. (2015). Analysing Financial Data and Implementing Financial Models Using R. Springer International Publishing, Switzerland.			
Number of hours of active teaching	**Theoretical teaching: 2**	**Practical teaching: 2**	
Teaching methods Work on case studies based on real-world data using computer laboratory.			
Assessment (maximum number of points 100)			
Pre-exam obligations	Points	**Final exam**	Points
Activities during semester	**5**	Written exam	**15**
Practical part	**5**	Oral exam	**15**
Colloquium	**40**	.....	
Seminar paper	**20**		

Table 5.2. Course specification

Study program: Advanced Data Analytics in Business			
Course title: Internship			
Teachers:			
Status of the course: Obligatory			
Number of ECTS: 4			
Condition: None			
Goal of the course Acquiring necessary knowledge and experience about work and organization of companies in the field of business analytics, and also possibility of implementing previously obtained knowledge into real-life situations.			
Learning outcome Student is capable of implementing previously acquired theoretical and practical knowledge into solving concrete real-life problems in companies in the field of business analytics. Student has valuable knowledge and experience in the field of business analytics obtained through work in real-life conditions.			
Content of the course *Theoretical part* *None.* *Practical part* *It will be defined for every student individually, through cooperation with representatives of companies or institutions where internship will be conducted, in line with requirements of profession of business analytics.*			
Literature			
Number of hours of active teaching	**Theoretical teaching:**	**Practical teaching:**	
Teaching methods Consultations with representatives of companies and teachers and writing of diary of professional internship where student will describe his activities and jobs in company			
Assessment (maximum number of points 100)			
Pre-exam obligations	Points	**Final exam**	Points
Activities during semester		Written exam	
Practical part	**100**	Oral exam	
Colloquium		.....	
Seminar paper			

Table 5.2. Course specification

Study program : Advanced Data Analytics in Business		
Course title: Machine Learning		
Teachers: Kupusinac Aleksandar, Brcanov Dejan, Ronald Hohrajter		
Status of the course: Obligatory		
Number of ECTS: 7		
Condition: No		
Goal of the course The aim of the course is that student builds an abstract thought within the area of machine learning and on the basis to master the possibilities of its application in data science. The student should apply the acquired knowledge from machine learning methods (linear regression, artificial neural networks, decision trees, associative rules, support vector machine, genetic algorithm) in solving real problems.		
Learning outcome Acquisition of modern knowledge and skills in machine learning. The student is able to study and solve real problems in data science by applying the acquired knowledge from the application of machine learning methods. Solving concrete problems with use of algorithms and techniques of machine learning. Introduction of main machine learning techniques. Understanding of matrix problem set up, definition of criteria functions through probabilities and solving regression and qualification problems. Understanding optimization and regularization procedures, modular approach in multilayer architecture, and ansable of methods and techniques of dimension reduction.		
Content of the course *Theoretical part* 1. The concept of machine learning 2. Modeling based on machine learning 3. Linear regression 4. Artificial neural networks 5. Decision trees 6. Associative rules 7. Support vector machine 8. Genetic algorithm 9. Application of the method of machine learning in the data science 10. Big data analysis 11. Predictions 12. Evaluations 13. Application of the method of machine learning in the prediction and evaluation 14. Classification 15. Application of the method of machine learning in the classification *Practical part* Selected methods and techniques of machine learning. Selected problems that require the implementation of methods and techniques of machine learning for their solving. Application of machine learning in different fields. Analysis and development of concrete examples.		
Literature 1. Ethem Alpaydin: Introduction to Machine Learning, MIT Press, 2004 2. M. Magdon-Ismail, Y. AbuMostafa: Learning from Data, AMLBook, 2012 3. S. Shalev-Schwartz, S. BenDavid: Understanding Machine Learning: From Theory to Algorithms, Cambridge university press, 2014 4. Goodfellow, I., Bengio, Y., Courville, A.: Deep Learning, MIT Press, Cambridge, 2017 Bishop, C.M.: Pattern Recognition and Machine Learning, Springer, New York, 2006		
Number of hours of active teaching	**Theoretical teaching:** 2	**Practical teaching:** 3
Teaching methods		

Lectures. Computer practice. Consultations. The student is obliged to independently do the project and write a seminar paper.			
Assessment (maximum number of points 100)			
Pre-exam obligations	Points	**Final exam**	Points
Project	50	Theoretical exam	30
Seminar paper	20		

Table 5.2. Course specification

Study program: Advanced Data Analytics in Business

Course title: Managing, Storage and Visualising Big Data

Teachers: Mirko Savić, Laslo Šereš, Lukas Cironis

Status of the course: Obligatory

Number of ECTS: 7

Condition: None

Goal of the course

The goal of the course is to give students an in-depth understanding of a wide range of fundamental Big Data Management systems. In particular, this course focuses on the "variety" of the 3Vs in big data, where how to store, index and query various types of data in a real-world application. Moreover, this course provides knowledge needed for solving big data management problems, which include data cleaning, data integration, data update, query processing and to learn students how to use tools for visualising big data for business analytics.

Learning outcome

The basic outcomes concern: 1) Problem Solving: Ability to model and implement efficient big data solutions for various application areas using appropriately selected tools and architectures. 2) Critical Analysis: Ability to analyse big data infrastructures and their components, to compare and evaluate them, and make appropriate design choices when solving real-world problems. 3) Communication: Ability to motivate and explain trade-offs in big data platform design and analysis in written and oral form. Student is capable of visualising big data in an effective way and to draw conclusions in the context of business analytics.

Content of the course

Theoretical part

1. *Big data in business*
2. *Managament of big data*
3. *Data types*
4. *Data collecting*
5. *Data cleansing*
6. *Data storing*
7. *NoSQL Data Stores*
8. *Data indexing*
9. *Data querying*
10. *Introduction to visualisation, Getting Started with ggplot2*
11. *Toolbox, The Grammar*
12. *Layers, Scales, Axes and Legends, Positioning, Themes*
13. *Data Analysis, Data Transformation*
14. *Modelling for visualisation*
15. *Programming with ggplot2.*

Practical part

Work on case studies based on real-world data using computer laboratory.

Literature

1. Marr, B. (2017). Data Strategy: How to Profit from a World of Big Data, Analytics and the Internet of Things, Kogan Page, ISBN-13: 978-0749479855
2. Kleppmann, M. (2017). Designing Data-Intensive Applications: The Big Ideas Behind Reliable, Scalable, and Maintainable Systems, O'Reilly Media, ISBN-13: 978-1449373320
3. Sullivan, D. (2015). NoSQL for Mere Mortals, Addison-Wesley Professional, ISBN-13: 978-0134023212
4. Wexler, S. (2017). The Big Book of Dashboards: Visualizing Your Data Using Real-World Business Scenarios, Wiley, ISBN-13: 978-1119282716
5. Wickham, Hardley (2016), ggplot2-Elegant Graphics for Data Analysis, second edition. Springer, Houston, USA.
6. Chang, W. (2013), R Graphics Cookbook. O'Reilly, Sebastopol, Canada.

Number of hours of active teaching	**Theoretical teaching: 3**	**Practical teaching: 2**

Teaching methods

All lectures are conducted in computer lab.

Assessment (maximum number of points 100)

Pre-exam obligations	Points	**Final exam**	Points
Activities during semester	5	Written exam	15

Practical part	5	Oral exam	15
Colloquium (2 colloquiums times 20 points)	40	.....	
Seminar paper	20		

Table 5.2. Course specification

Study program: Advanced Data Analytics in Business			
Course title: Master Thesis			
Teachers:			
Status of the course: Obligatory			
Number of ECTS: 18			
Condition: None			
Goal of the course The goal of the work on the master thesis and its presentation is for student to prove that is able to conduct autonomous and creative approach in the application of practical and theoretical knowledge in the field of business analytics.			
Learning outcome Students finishing master thesis in the field of business analytics are competent to solve real-life problems in this area. Student has comprehensive knowledge and understanding of all courses of study program, and ability to solve real-life problems through use of scientific methods. Student is capable of writing and presenting the results of his work.			
Content of the course *Theoretical part* *No* *Practical part* *No*			
Literature			
Number of hours of active teaching	**Theoretical teaching:**	**Practical teaching:**	
Teaching methods Mentor in cooperation with employers' representatives and student is formulating the research area and topic of master thesis. Candidate through consultations with mentor and employers' representative and through autonomous work is developing master thesis. After finishing the paper, mentor is giving his approval, and candidate is presenting its thesis in front of the committee comprising of two members.			
Assessment (maximum number of points 100)			
Pre-exam obligations	Points	**Final exam**	Points
Activities during semester		Written exam	
Practical part		Oral exam	
Colloquium		Work on master thesis	**50**
Seminar paper		Presentation of master thesis	**50**

Table 5.2. Course specification

Study program : Advanced Data Analytics in Business
Course title: Quatntitive Fundamentals
Teachers: Aleksandra Marcikić Horvat
Status of the course: Obligatory
Number of ECTS:7
Condition: None
Goal of the course The goal of this course is to review a number of mathematical and statistical concepts and to develop basic arithmetic and algebra skills relevant for the study of data science. The course takes a practical, applied approach to mathematics and statistics in order to increase student appreciation of the material.
Learning outcome After completing the course, students are able to understand various quantitative and statistical methods, understand data and draw inference from data, to pose and solve financial-based problems by using previously stated methods on company-specific data.
Content of the course *Theoretical part* *Week 1: Vector spaces* *Week 2: Vectors* *Week 3: Matrices and* *Week 4: system of linear equations in matrix form* *Week 5: Real functions of one real variable* *Week 6: Application of derivatives to economic functions* *Week 7: Application of derivatives to economic functions* *Week 8: Application of integrals to economic functions* *Week 9: Application of integrals to economic functions* *Week 10: Descriptive statistics* *Week 11.: Probability* *Week12.: Distributions and Sampling* *Week13.: Making inferences about population parameters* *Week14.: Regression Analysis and Forecasting* *Week15.: Nonparametric Statistics* *Practical part* *Work on practical tasks, writing of seminar paper*
Literature 1. Soo T. Tan, Finite Mathematics for the Managerial, Life, and Social Sciences, Cengage Learning, 201 2. Poole, D., Linear Algebra: A modern introduction, Cengage Learning, 2014, 3. Black K. Business Statistics for contemporary decision making. John Wiley & Sons, Inc., 2010.

Number of hours of active teaching	**Theoretical teaching: 3**	**Practical teaching: 2**

Teaching methods Teaching will be done in classrooms, computer labs using appropriate teaching resources (multimedia presentations, software packages, etc.). Teaching takes place through lectures, exercises and independent work. Proof of knowledge is done through written and oral exams.
Assessment (maximum number of points 100)

Pre-exam obligations	Points	**Final exam**	Points

Activities during semester	**5**	Written exam	**20**
Practical part		Oral exam	**15**
Colloquium (3 colloquium of 20 points each)	**60**	.....	
Seminar paper			

Table 5.2. Course specification

Study program : Advanced Data Analytics in Business			
Course title: R for Data Science			
Teachers: Мирко Савић, Роналд Хохрајтер, Александар Купусинац			
Status of the course: Obligatory			
Number of ECTS: 7			
Condition: None			
Goal of the course The goal of the course is students to teach students at the beginning basic tools for management of big data in R language and later on advanced tools and be capable to program in R language. The entire course is in the context of business environment and through examples of good praxis, because the final goal is for student to develop competencies related to R language in order to implement them for the need of business analytics in fast and efficient way.			
Learning outcome Student know and understands R language, uses R studio, ggplot2, tidyverse and collection of packages for massive data. Student imports, manipulates, analyse and models data. Student knows how to communicate results of analysis to final users.			
Content of the course *Theoretical part* *1-2. Basics of R language* *3. Relationship of statistics and R language* *4. Relationship of econometrics and R language* *5. Data visualisation* *6. Data transformation* *7. Writing of scripts* *8. Exploratory data analysis* *9. Projects in R package* *10. Data wrangling* *11-13. Programming* *14. Modelling* *15. Communication of results.* *Practical part* *Work on practical tasks, writing of seminar paper on the basis of theoretical topics and learning R language in computer lab.*			
Literature 1. Wickham, H., & Grolemund, G. (2016). R for Data Science - First Edition. O'Reilly, Sebastopol, Canada. 2. Peng, D. R. (2015). R Programming for Data Science. Lulu Press Inc. 3. Dalpiaz, D. (2018). Applied Statistics with R. University of Illinois, USA. 4. Chang, W. (2013), R Graphics Cookbook. O'Reilly, Sebastopol, Canada.			
Number of hours of active teaching	**Theoretical teaching: 3**	**Practical teaching: 2**	
Teaching methods All lectures are conducted in computer lab.			
Assessment (maximum number of points 100)			
Pre-exam obligations	Points	**Final exam**	Points
Activities during semester	**5**	Written exam	**15**
Practical part	**5**	Oral exam	**15**
Colloquium (2 colloquiums times 20 points)	**40**	.....	
Seminar paper	**20**		

Table 5.2. Course specification

Study program: Advanced Data Analytics in Business

Course title: Social Media Analytics

Teachers: Grljević B. Olivera

Status of the course: Obligatory

Number of ECTS: 7

Condition: None

Goal of the course

To familiarize students with a) social media sites as the data sources for business analytics, b) the power and significance of user-generated content, and c) various possibilities of analysis of social media content which allows companies to observe the overall market position of a company, product, or competition. To teach students to obtain relevant data from the Internet, to retrieve them and visualize them, to analyse textual content from social media, as well as the emotions from user-generated content from social media.

Learning outcome

Student has the knowledge to to solve complex problems which require application of categorization and clustering of texts, topic modelling, and sentiment analysis; Student has the knowledge to select adequate data source and to retrieve the data from the Internet; Student has the knowledge to create dataset and to prepare it for analysis; Student knows to visualize data (graphical representation of large amount of data, word clouds, and similar); Student knows how to choose an adequate approach to analyze data and to practically apply clustering, classification techniques, association rules on data from the Internet; Student knows to interpret obtained results.

Content of the course

Theoretical part

1.Understanding business benefits of social media analysis and analysis of data obtained from the Internet.

2.Introduction to text mining and natural language processing.

3-4.Introduction to specificities of user-generated content and ways to retrieve them.

5.Model and pre-process textual data for analysis.

6-7.Data mining methods and techniques for analysis of textual data.

8. Classification algorithms, clustering, topic modelling and keywords modelling in texts, sentiment analysis.

9.Basics of image mining.

10.Natural language processing and pre-processing of data.

11.Visualization of data.

12. Collecting and creating datasets for machine learning and data mining.

13-14.Application of text classification, sentiment analysis, application of clustering techniques for grouping similar text and keywords.

15.Illustration of possibilities of applying classification algorithms for image analysis.

Practical part

Work on practical tasks, writing of seminar paper on the basis of theoretical topics

Literature

1. Bing Liu, Sentiment analysis and Opinion Mining, Morgan & Claypool Publishers, 2012.
2. Bo Pang, Lillian Lee, Opinion Mining and Sentiment Analysis, Foundations and Trends in Information Retrieval, Vol. 2, Nos 1-2 (2008) 1-135.
3. Daniel Jurafsky i James H. Martin. 2018. Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition.
4. Weiss, M. S, Indurkhya, N., Zhang,T. Fundamentals of Predictive Text Mining, Springer-Verlang, 2010.
5. Ronen Feldman, James Sanger, The Text Mining Handbook – Advanced Approaches in Analysing Unstructured Data, Cambridge University Press, 2013.

Number of hours of active teaching	**Theoretical teaching: 3**	**Practical teaching: 2**

Teaching methods

lectures, discussions, and practical exercises and work on various case studies in computer laboratories

Assessment (maximum number of points 100)

Pre-exam obligations	Points	**Final exam**	Points
Activities during semester	**5**	Written exam	
Practical part	**5**	Oral exam	**30**
Colloquiums (three times 20 points)	**60**	.....	
Seminar paper			

Table 5.2. Course specification

Study program : Advanced Data Analytics in Business

Course title: Time Series

Teachers: Boris Radovanov, Dragan Stojić, Schluter Stephan

Status of the course: Obligatory

Number of ECTS: 7

Condition: No

Goal of the course

The goal of the course is to illustrate time series analysis using many applications in fields of economics and finance, but also in other fields of science.

Learning outcome

Students will be given fundamental grounding in the application of such widely used tools in modelling time series. The models passes through the phases of indentification, diagnostics and forecasting. By the end of this course, students will be familiar with the implementation of time series models using adequate statistical software along with the interpretation for results derived from model implementation.

Content of the course

Theoretical part

1-3. Time series introduction

4. Univariate models

5-6. ARMA models

7-8. ARIMA models

9-10. GARCH models

11-12. VAR models

13. Visualisation

14-15. Forecasting using selected models.

Practical part

Implementation of time series models using statistical software through work on the case studies in selected fields.

Literature

1. Chatfield, C. (2003). The Analysis of Time Series: An Introduction. Sixth Edition. Chapman and Hall/CRC
2. Tsay, R. (2002). Analysis of Financial Time Series. John Wiley & Sons, Inc.
3. Cowpertwait, P. & Metcalfe, A. (2009). Intoduction Time Series with R. Springer Science.
4. Shumway, R. & Stoffer, D. (2011). Time Series Analysis and Its Application: with R Examples. Third Edition,

Number of hours of active teaching	**Theoretical teaching: 2**	**Practical teaching: 3**

Teaching methods

All lectures are conducted in computer lab using appropriate software packages.

Assessment (maximum number of points 100)

Pre-exam obligations	Points	**Final exam**	Points
Activities during semester	**5**	Written exam	**15**
Practical part	**5**	Oral exam	**15**
Colloquium	**40**	.....	
Seminar paper	**20**		

Table 5.2. Course specification

Study program : Advanced Data Analytics in Business			
Course title: Supply chain & Operational Analytics			
Teachers: Nebojša Gvozdenović, Dejan Brcanov, Loukas Tsironis			
Status of the course: Elective			
Number of ECTS: 7			
Condition: No			
Goal of the course Goal of the course is a mastery of the essential elements of the supply chain analytics: Data management - collection, cleaning, manipulation, visualisation; Segmentation - products, suppliers and customers; Forecasting - techniques, aggregation, Demand management – process metrics, price optimization.			
Learning outcome Student knows to explain the importance of supply analytics, efficiently handles the available business information/data, can use analytical tools like Python, R, SPSS and MS excel efficiently in order to take managerial decisions more effectively.			
Content of the course *Theoretical part* *Week 1: Introduction to supply chain.* *Week 2: Supply chain Flows.* *Week 3: Data produced by supply chains.* *Week 4: Data cleaning and Manipulation.* *Week 5: Statistical analysis.* *Week 6: Data Visualization.* *Week 7: Product segmentations single and Multi-criteria.* *Week 8: Supplier segmentations and customer's segmentations.* *Week 9: Forecasting - techniques, accuracy testing, aggregation approaches.* *Week 10: Pricing and Markdowns optimization Techniques.* *Week 11: Inventory Policy and Safety stock Calculations* *Week 12: Inventory simulations.* *Week 13: Machine Learning for supply-chain.* *Week 14: Product Recommendations for customers.* *Week 15: Simulations for optimizing Capacity and Resources.* *Practical part* *Application of Supply Chain Models.*			
Literature 1. Albright, C. & Winston,W. (2015). Business analytics: data analysis and decision making - 5th edition. Stamford, CT, USA. 2. Chopra, S. & Meindl, P. (2013). Supply chain management:Strategy, planning and Operation - 5th Edition. Pearson Education, New Jersey, USA. 3. Hyndman, R.J., & Athanasopoulos, G. (2018) Forecasting: principles and practice, 2nd edition, OTexts: Melbourne, Australia. OTexts.com/fpp2. Access date 13.05.2019. **4.** James, G., Witten, D., Hastie, T., & Tibshirani, R. (2013). An introduction to statistical learning: with application in R, New York: Springer			
Number of hours of active teaching	**Theoretical teaching: 2**	**Practical teaching: 2**	
Teaching methods Lectures, discussions, paper writing on teaching subjects.			
Assessment (maximum number of points 100)			
Pre-exam obligations	Points	**Final exam**	Points
Activities during semester	**5**	Written exam	**15**
Practical part	**5**	Oral exam	**15**
Colloquium	**20**	.....	

Seminar paper	**40**		

Table 5.2. Course specification

Study program : Advanced Data Analytics in Business

Course title: Transaction-Based Analytics & Recommendation Systems

Teachers: Ronald Hochrajter, Zita Bošnjak, Jason Papatanasiu

Status of the course: Elective

Number of ECTS: 7

Condition: None

Goal of the course

The goal of the course is to enable students to preprocess data sets from the web, which are not in a matrix format ready for modelling (Design Matrix) and to use the prepared data within specific Data Mining tasks and Data Science frameworks.

Learning outcome

The students should understand that in most cases transaction-based data contains more than one dimension of information, e.g. online customer action over time. Also, they should understand when and if a data set is not a Design Matrix ready to be used for Machine Learning (supervised and unsupervised) but rather requires a semi-automatic conversion into e.g. Rating Matrices, which can be binary or integer/real-valued.
When a conversion into one (or more) rating matrix/matrices is possible then the students should be able to conduct Association Analysis as well as being able to design Recommender Systems using Collaborative Filtering.
The difference between Collaborative Filtering and Content-based Filtering is relevant and students should be able to create hybrid recommenders.
Students should be aware of the importance of the excerpt of the data used for modeling (e.g. a certain time-frame or demographic structure).
Finally students should be able to conduct Feature Engineering if a semi-automatic conversion is not possible, e.g. a RMF analysis for online store data.

Content of the course

Theoretical part

Week 1 – Machine Learning
Week 2 – CRISP–DM Methodology and Web Usage Mining Methodology
Week 3 – Preprocessing Unstructured Data for Exploratory Data Analysis and Modelling
Week 4 and 5 – Different Types of Transaction-based Data - Market Baskets (User/Product), Matchmaking (User-to-User, Item-to-Item)
Week 6 and 7 – Overview of Recommender-Systems - Content-based filtering, Collaborative Filtering (Demography, Time, Location)
Week 8 – Semi-automatic Conversion of Transaction-based Data - Rating Matrices (Binary, Real-valued)
Week 9 – Association Rules;
Week 10 and 11 – Model-based Recommender Systems and Evaluation;
Week 12 – Feature Engineering
Week 13 – Manual Conversion of Transaction Data – RMF Analysis & Customer Grouping
Week 14 – Evaluating Recommender Systems
Week 15 – Ethical Aspects of Intelligent Data Analysis

Practical part

Week 1 – Preprocessing of selected unstructured data sets for exploratory analysis and modeling
Week 2 – Conversion of transaction data into a matrix (or multiple matrices) of ranks
Week 3 – Calculating similarities / customer-customer overlaps in different transaction data sets
Week 4 – Calculating similarities / item-item overlaps in different transaction data sets
Week 5 – Selected case studies on content filtering
Week 6 – Selected case studies on collaborative filtering (Demography, Time, Location)
Week 7 – Preprocessing data for associations mining
Week 8 – Mining association rules, influence of support and confidence parameters, reducing the number of rules
Week 9 – Preprocessing transactional data for modeling - clustering and classification
Week 10 – Design, implementation and evaluation of recommendation systems
Week 11 – Data sampling and manual feature engineering
Week 12 – RMF analysis of online store data
Week 13 – 15 – Presentation and analysis of individual students′ work

Literature

1. Aggarwal, Charu C. (2016) Recommender systems: The Textbook, Springer
2. Jure Leskovec, Anand Rajaraman, Jeff Ullman (2014) Mining of Massive Datasets, Cambridge University Press

Number of hours of active teaching	**Theoretical teaching:** 2	**Practical teaching:** 2

Teaching methods

Classroom lectures (multimedia presentations)
Practical work in a computer lab (relevant software tools and packages)
Consultations

Teaching takes place through lectures, exercises and making two assignments and an indipendent practical work (data analysis task). Proof of knowledge is in the form of 2 colloquia, presentation of the independent practical work (these are pre-examination obligations) and an oral exam.
Positively assessed pre-examination obligations and two assigments are all valid in the current academic year.

Assessment (maximum number of points 100)

Pre-exam obligations	Points	**Final exam**	Points
Activities during semester	5	Indipendent practical work	15
Practical part	5	Oral exam	15
Colloquium	2 times 20 points	.....	
Assignments	2 times 10 points		