ADA
ADVANCED DATA
ANALYTICS IN BUSINESS

Co-funded by the
Erasmus+ Programme
of the European Union

Evaluation of ADA Study Programs, Evaluator 1 (Mario Annau)

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Project acronym:	ADA
Project full title:	Advanced Data Analytics in Business
Project No:	598829-EPP-1-2018-1-RS-EPPKA2-CBHE-JP
Funding scheme:	ERASMUS+
Project start date:	November 15, 2018
Project duration:	36 months

Abstract	After the first version of curriculum, content of courses and methodology finished, two external experts were engaged in order to evaluate the quality of the developed master program. This report represents their evaluation. On the basis of the report, the consortium will correct the elements of the master program if necessary.

Title of document:	Evaluation of Study Programs
Work package:	WP 5: Quality plan
Activity:	5.4 Report on external evaluation
Last version date:	21/02/2022
File name:	5.4 Report on external evaluation
Number of pages:	22
Dissemination level:	International

Contents

● Advanced Data Analytics in Business (University of Novi Sad)

- Program Overview

The master programme Advanced Data Analytics in Business at the University of Novi Sad takes 4 Semester (120 ECTS points). Through its focus on contemporary modelling techniques in the context of business analytics students will be key players in companies going through digital transformation in coming years and will be able to deliver immediate value to future employers. With a share of 50% practice throughout the entire masters programme the applicability and usefulness of advanced analytics techniques can lead to a much higher business value for a broad range of companies and startups. Nevertheless, the programme ensures solid theoretical foundations through subjects such as Quantitative Fundamentals, Time Series Analysis and Big Data.

The masters programme consists of eight compulsory- and five elective subjects. Each subject carries 7 ECTS. Compulsory subjects are scheduled only for the first year which gives students more flexibility in the second year where they can choose electives possibly related to their master thesis.

The first year, with 8 compulsory subjects plus a company internship (4 ECTS) thus totals 60 ECTS or 600 total hours (300 lecture, 300 practice).

The second year, with five elective subjects, a professional-scientific work (7 ECTS) and a master thesis (18 ECTS) also results in 60 ECTS. The master thesis is done with a mentor from a cooperation on applied subjects related to the field. The cooperation with companies on the master thesis has multiple benefits. First, it makes sure that the thesis has more practical relevance and ideally can be directly applied within the company. Second, companies can evaluate advanced analytical techniques for their business use cases without risk or hiring costly consultancy companies. Third, these companies could be possible future employees and already have open doors for potential job interviews.

Throughout the intense cooperation between the university with local companies the master programme can even better bridge the gap between advanced analytics and business applications.

- Analysis of the contents and the relevance of the covered courses

First Year

Throughout the first year students need to go through eight compulsory courses which shall give them a strong foundation in data analysis, quantitative methods and programming/computer science::

- *Quantitative Fundamentals:* The goal is to learn basic algebraic and analytical concepts applied to (economic) functions. The course also covers basic probability theory and statistics including regression analysis and forecasting. After completion of the course students shall be able to apply these skills on company specific data to solve a range of relevant business problems. Assessments are based on written and oral exams as well as 3 colloquia and semester activities.
- *Managing, Storage and Visualising Big Data:* In this course students are introduced to big data management systems and learn how to store, index and query various data types based on real-world applications. The course covers all major data management workflows such as data collection, cleansing, storage, indexing and querying based on contemporary big data technologies including NoSQL data stores. Additionally, students will learn how to effectively present results based on visualisation tools based on the grammar of graphics, such as the ggplot2 R package.
- *Social Media Analytics*: The goal of this course is to collect, analyse and apply data from social media sites in the business context. Students shall be able to analyse the market position/sentiment of companies, customer reviews and sentiment for specific products and services and analysis of the competition in specific markets. Text mining skills acquired include text categorization, clustering topic modelling and sentiment analysis. Additionally, students will learn how to effectively retrieve required data from the web through e.g. relevant APIs and prepare datasets for subsequent analysis. Assessments are done through an oral exam, 3 colloquia, a practical part and activities during the semester.
- *R for Data Science:* This course aims to teach students the basics of the R programming language to solve data science problems using the RStudio IDE and the tidyverse package universe including ggplot2 and dplyr. Students need to be able to clearly communicate results to a potential user within a relevant business context. This course involves hands-on lectures all conducted in a computer lab. The final assessment is based on a written and oral exam, a seminar paper, 2 colloquia, and activities during the semester.
- *Machine learning:* This course teaches students fundamental concepts in machine learning and its real-world applications. The most important model families are covered including linear regression, neural networks, decision trees, support vector machines, rule learners, and genetic algorithms. Additionally, regularisation techniques and dimensionality reduction to conquer overfitting and collinearity/curse of dimensionality are covered. However, main emphasis is on the application of machine learning techniques on business related use cases including the definition of relevant KPIs, setup of the model-matrix and successfully solving a business critical use case. The assessment is based on a theoretical exam, a seminar paper and a project (50%).

- *Big Data Fundamentals:* The goal of this course is to store, clean and analyse (big) data sets to solve and support the decision making process. The course covers relational as well as non-structured data sets and storage systems. Teaching is conducted in a computer lab through lectures, exercises and independent work. Assessment is done through written and oral exams, a colloquium, seminar paper and activities during the semester.
- *Time Series*: The goal of this course is to give students a foundational understanding and toolset for time series analysis with applications in economics and finance. Classical ARIMA, GARCH and VAR models are covered including visualisations and practical forecasting examples. The lectures are conducted in the computer lab. For all practical exercises teh R programming language is used. The assessment is done based on a written and oral exam, colloquium, seminar paper, a practical part and activities during the semester.
- *Business Cases*: This course is centred around practical application of data science and optimization in business. Concrete real-live examples are presented and solved with data science techniques. Among the areas of data science applications are finance, marketing, management of industrial processes, health management, agricultural production, supply chain management, inventory management and business information systems. The practical part is done using the Lindo/Lingo Excel add-in. The assessment is mostly done through written and oral exams, 2 colloquia and a seminar paper.

Second Year

During the second year students can chose five **elective courses** among a pool of ten to obtain further insights in specific topics:

- *Designing communication of results*: The goals of this course are two-fold: 1) transformation of raw data into meaningful business insights and 2) development of ethical competences regarding all relevant data processes. The ethical competences cover all issues regarding data protection (privacy) and an equality (bias-free) framework. The course is conducted in the computer lab and assessed through written and oral exams and (pre-exam) colloquia, a seminar paper, a practical part and activities during the semester.
- *Academic Writing*: Students learn how to conduct academic research and write academic texts including literature review, extract and summarise relevant information and write valid research proposals. The course is conducted through lectures and discussions. As part of the final assessment, a seminar paper is written in addition to a written and oral exam.
- *Business & Decision Modelling*: The goal of this course is to apply quantitative methods and tools to business problems to make informed decisions. Students are able to apply these methods to a range of different domains and objectives including inventory optimization or cost optimization. Methods include linear programming (LP), integer- and nonlinear programming. The course is conducted in the classroom and lab. The LINDO/LINGO Excel Software suite is used for practical exercises.
- *Supply chain & Operational Analytics*: The course covers all major elements of supply chain management including data handling, product segmentation, forecasting and price

optimization. Students shall be aware of supply chain analytics and use common tools (Python, R, SPSS, Excel) to support management decisions. The literature list covers business/supply chain as well as statistical learning and forecasting topics (Hastie, Hyndman). The practical part consists of the application of supply chain models.

- *Digital Marketing Analytics*: Students are introduced into the marketing process and learn how to successfully implement and measure digital marketing activities. The course covers topics like targeted marketing, segmentation, and price differentiation, among others. The course is assessed through a colloquia and a seminar paper (per exam) and a final written exam.
- *Financial Analytics*: This course gives an introduction to the stock market and an introduction into financial statistics and risk metrics, time series and analysis and forecasting techniques. Finally, it covers the simulation and performance measurement of trading strategies/portfolios. The course is completely lab-based and is finally assessed through a seminar paper and colloquium (pre-exam) and a written- and oral exam.
- *Advanced Analytics with SPSS*: Students get familiar with the SPSS data analysis suite to handle the entire data management workflow including data import, management, and (exploratory) statistical analysis. In addition to the SPSS language the course covers basic statistical concepts including t-tests, ANOVA, chi-square tests, correlation analysis and regression. The course is conducted in computer labs.
- *Transaction-based analytics & Recommendation systems*: The goal of this course is to enable students transform collected data from the web into formats which are ready for modelling and design of recommender systems. Students shall be able to create e.g. rating matrices and differentiate between collaborative and content based filtering. In addition to recommendation systems students are introduced to the CRISP-DM framework and learn about the ethical aspects of such systems. The course is taught through classroom lectures and in the computer lab. Pre-exam assignments are mostly based on 2 colloquia, 2 assignments, and an independent data analysis task in addition to a final oral exam.
- *Deep Learning*: This course teaches students to build deep learning models and how to apply them to business-related problems. Students are introduced to the theory behind these powerful neural networks and select the right model type and complexity to solve specific problems. The Python programming language with the popular Keras/Tensorflow library is used to create CNN, RNN or LSTM neural network architectures. The popular books in the field by Goodfellow and Chollet are part of the literature list. The course is taught through lectures and exercises in the computer lab. Grading is mostly based on 2 colloquia, a seminar paper and oral exam.
- *Advanced Econometrics*: This course aims to introduce students to advanced econometric methods including (multinomial) logistic regression, survival- and spatial analysis and time series. Students shall be able to answer specific economic questions using appropriate models, data and assumptions. Software used include GRETLS, EVIEWS and R. The course is taught in the computer lab and assessed through write and oral exams, 2 colloquia, and (practical) activities during the semester.

● Advanced Data Analytics (University of Belgrade)

- Program Overview

Advanced Data Analytics (ADA) at the University of Belgrade is a 3-semester 90 ECTS master programme introducing students to mathematical foundations of data analytics as well as computational tools and techniques. The programme fits perfectly with current and future job market needs and developments requiring students to analyse ever increasing amounts of data and apply sophisticated modelling techniques to question the status quo and reach novel conclusions.

The programme allows students to to choose a number of subjects from 3 main areas:

- Mathematical / statistical foundations
- Computing skills, tools and technologies for data analytics
- Application of data analytics skills, tools and techniques in different domains

Compared to other programmes students have a relatively high degree of freedom by choosing a set of elective courses from each of the 3 main topics. The first two areas help students to build up foundational mathematical and computational skills which shall be helpful in a variety of different domains. The third area gives students the opportunity to strengthen their data analysis skills and broaden their horizon through numerous applications and domains such as biology, medicine or space. Advanced data analysis methods and techniques can be applied to a large number of different areas and breakthrough innovations are often the result of familiar techniques applied to different areas.

After going through the programme students should therefore be able work in all major industries and find novel and create solutions to all kinds of data challenges. It is expected that advanced data analytics and machine learning will influence a large number of domains and alumni of this programme will be in perfect shape to conquer current and future challenges involving data analytics and computer science in the jobs market.

- Analysis of the contents and the relevance of the covered courses

Students are allowed to choose 3 out of 6 elective courses (10 ECTS each) from the topic area **mathematical / statistical foundations:**

● *Mathematical foundations of data analysis*: This course aims to provide students with basic knowledge in linear algebra and numerical analysis. Students use the programming language R to perform basic operations on data structures such as matrices, multiplication and inversion., calculation of eigenvalues, interpolation and fourier transformation. The subject gives solid mathematical underpinnings for more advanced data analytics subjects.
● *Discrete structures*: Familiarise students with discrete mathematical topics and ways for formal deductions. Concepts such as first order logic, graph theory and finite automata are elementary foundations to understand advanced concepts in programming and algorithms. The course is conducted through lectures and hands-on labs.
● *Analytics and optimization*: The objective of this course is to enable students to solve real-world problems through optimization and operations research. Based on collected real-world data students will be able to formulate the optimization problem and objective, apply common optimization techniques and communicate/visualise obtained results. Tools to be used are e.g. MS Excel based and the AMPL language for optimizers. Grading is mostly based on a practical case study (60%).
● *Introduction to statistical inference*: Course on statistical analysis and inference as well as on computational tools using the R programming language. In addition to a number of introductory concepts including random variables and distributions the course covers confidence intervals, hypothesis testing and regression models. The course is also taught in computer labs to directly teach students all relevant statistical tools. Grading is based on a project conducted during the semester and a final verbal exam.
● *Models of statistical learning*: Advanced course on statistical learning techniques based on literature by Hastie and Tibshirani. Students get introduced to advanced statistical learning techniques including lasso regression and support vector machines. Also resampling techniques including cross validation and bootstrap are covered to avoid overfitting. Students are graded based on the implementation of a project using contemporary statistical software such as R. The course is finally graded based on a verbal exam.
● *Introduction to complex networks theory*: Students are familiarised with network/graph theory including concepts like degree, centrality and clustering and distance metrics. The course also includes various hands-on computer labs where students are able to analyse real systems/networks using the Python networkx module. Assessments are done based on homework and a final project.

To strengthen the computational skills of ADA students, there are 3 out of 9 courses (10 ECTS each) to be chosen out of the area related to **computing skills, tools and technologies for data analytics**:

● *Programming*: The aim of this course is to give students a solid foundation in programming in a data-centric programming language such as Python or R. Additionally, students will be able to use the language for efficient data processing, analysis and visualisation. The course is therefore a good introduction for students who only have minor programming experience who want to get ready for more sophisticated data analysis/science projects.

● *Databases*: The goal of this course is to enable students to understand data storage requirements and design data base systems fitting current needs. The contents of the course are divided into relational (SQL) based systems and NoSQL systems. Although relational database systems still represent the majority in most companies, NoSQL systems are gaining traction since they have unique advantages such as horizontal scaling capabilities. The course therefore fits perfectly with current needs in companies.
● *Big data analytics*: The course objective is to give an introduction to Big Data analytics including datasets and tools based on the R programming language. Students are introduced into the entire (Big) data analytics workflow including data cleaning, aggregation and visualisation. The Spark 2.0 in combination with the R programming language are being used throughout the course. Another important aspect is the ethical part of this course which is getting increasingly important over the last years. The course is graded based on a hands-on project and a verbal exam.
● *Data visualisation*: Since data visualisation is highly relevant in communicating results and for exploratory data analysis this course fits perfectly with the ADA programme objectives. Using the R or Python programming language students are introduced to the grammar of graphics and data transformations to efficiently create plots. The course is graded based on practical exercises only such as a project implementation and by solving a final data visualisation problem.

● *Artificial Intelligence / Machine learning*: Course with a focus on artificial intelligence and intelligent systems to give students a broad overview of the topic. The course covers basic concepts based on the Russel/Norvig classical textbook. Labs are covering all areas of the course using the R, Python and Java programming languages. Covered techniques include rule learning, linear regression, classification and clustering. Also, basic concepts of Neural Networks are included. The course is graded based on a simple and final project work.
● *Neural networks and deep learning:* Contemporary course covering neural network architectures for different applications and up-skill students to use neural network architectures to solve practical problems. Theory is covered by classical literature in the field by e.g. C. Bishop and I. Goodfellow. Application problems to be solved include classification, prediction and clustering. The course is graded based on a practical project assignment.
● *Text mining:* The course objective is to introduce students to a typical text mining workflow for data preprocessing. Students shall be able to perform various text mining tasks including text classification, clustering, topic modelling and summarization. Students thus are able to transform unstructured data into meaningful information for businesses and decision makers. The course is completely hands-on - programming languages used include R and Python. The course is graded based on simple use cases, followed by a (full) real-world application.
● *Social network analysis*: Students get acquainted with social network analysis methods and how they can be used for their business (problems). Gaining knowledge in these techniques and their limitations can have immediate business value in fields such as marketing. The course is completely example and practice based. Languages used are R and Python with packages suited for social network analysis. The course is graded based on a simple and real-world social network analysis project.
● *Introduction to time series analysis:* The goal of this course is to introduce students to many different aspects and techniques in time series modelling including stationarity, auto-corellation, and ARIMA models. Based on Shumway/Stoffer literature students shall be able to successfully

model and describe time series using modern statistical software such as R. The course is graded based on practical homework and a final project based on the application of a real-world system.

Students can choose 2 out of 8 subjects (7 ECTS each) from the area application of **data analytics skills, tools and techniques in different domains**:

● *Data analysis in fundamental and clinical medicine*: This highly relevant course in the field of medical informatics introduces students to the applications of data analytics to medicine. These applications include signal processing including cardiography and microscopy and others. Additionally, students get introduced to medical statistics and tests used to process data and evaluate studies.
● *Data analysis in biological sciences*: Students learn how to analyse highly complex and relevant biological data including genomics (nucleic acids) and proteins, image data from electron microscopy and neuroscience. Additionally, students learn how to conduct statistical tests in biological research. The subject is graded based on practical work on a project concept (pre-exam) and the finally implemented project. The subject definitely broadens the skillset and horizon of students in that field.
● *Advanced data analysis in pharmaceutical research and development*: The course objective is to teach students the role of data analytics in drug development including numerous methods to measure quality and behaviour. This subject presents the intersection between pharmacy and computations methods and thus gives contemporary insights into the field. The course is graded based on a practical project.
● *Practical analysis of noisy and uneven time series*: A highly relevant course for any students and (later) practitioners who experience noisy time series data sets including missing values, non-stationarity, etc. The course also covers various processes for time series modelling (gaussian, poisson) and maximum likelihood estimators. Hands-on activities, class activities and a final oral exam are used as assessments.
● *Big Data in space science and its analysis*: The goal of this course is to introduce students to all different kinds of space data from various telescopes and organisations. Using the Python programming language students will use the entire image understanding toolchain including visualisation, dimensionality reduction techniques, and modelling. Modelling is performed using the scikit-learn framework and covers hyperparameter tuning and model selection. This course thus gives a broad introduction to satellite/telescope data and image processing techniques at the same time - with increased activities in space exploration over recent years definitely an interesting job field for decades to come.

● *Advanced data analysis in social sciences*: Introduction to statistical methods for social sciences with an emphasis on practical applications. Students learn how to deal with social/demographic data using numerous modelling techniques like correspondence analysis, regression and non-linear models. Practical solutions are implemented in languages like SPSS, STATA and R to complete the project presentation and the final research paper.
● *Big Data in social sciences*: Nowadays nearly every app collects thousands of data points from its users for possible later re-use and improvements. Modelling social behaviour with big and rich

data sets is an ever growing and relevant field in many different domains. Students learn how data is collected and can be modelled to derive useful business information. The highly relevant ethical aspects under consideration with legal frameworks such as GDPR are also covered by the course - very relevant topics for years to come.

- *Analysis of international research datasets*: The main objective of this course is to students acquainted with official statistics providers and tools on how to analyse them. It covers macro- and microeconomic data as well as comparative micro- data. Students learn how to model and data and derive interesting results from it. Additionally, students see how these results could be incorporated into new studies and policies. The course is graded based on a presentation and final research paper.

The **Internship** (3 ECTS) allows students to apply their data analytics skills in practice with partner companies and mentors/advisors. The cooperation with companies increases the practical relevance of the programme and already creates deep connections between universities and possibly future employers.

To prepare for the master thesis students need to write a **qualification paper**/term paper (5 ECTS). Through paper writing students already dig into the topic with their thesis advisors and can perfectly prepare by stating the research objective, do literature review and and solve specific problems using advanced data analysis.

By writing the final **master's thesis** (10 ECTS) students can conduct research using state-of the art data analysis models and try to validate their initial research hypothesis and objectives. The practical relevance of the thesis is validated by the advisor since it needs to be based on a practical analysis project.

It is generally advised to combine the Internship, term- paper and thesis around one topic to improve overall quality and to increase practical knowledge.

● Advanced Data Analytics in Business (University of Niš)

- Program Overview

The master programme Advanced Data Analytics in Business at the University of Niš takes 3 Semesters (90 ECTS points). The first two semesters each consist of three compulsory courses and 2 electives. Each course is valued at 6 ECTS with a total of 30 ECTS over the semester or 60 ECTS over the year.

The programme gives a solid foundation in statistics, computer science and machine learning to enable students to analyse ever growing data sets with sophisticated tools and methods. The ability to condense large amounts of data into valuable information for decision making and products will be a highly relevant skill set for decades to come.

The programme has many subjects related to (quantitative) finance and clearly sets a focus in that area. Especially the second semester with compulsory subjects like time series forecasting, econometrics and quantitative finance has a very strong focus on finance.

Additionally, the programme includes subjects such as marketing intelligence which are in high demand thanks to more and more digital products and users in different industries. The right use of data for marketing efforts and product development is highly relevant for overall business outcomes.

The strong focus on subjects including practical exercises underpins the highly applied nature of the masters programme and gives students strong foundations in “classical” quantitative finance operations research subjects as well as novel machine learning and data analysis techniques.

The third semester is concentrated on a company internship and masters’ thesis which gives students the opportunity to apply and further research advanced data analysis techniques in real-world situations.

- Analysis of the contents and the relevance of the covered courses

First Semester

The first semester gives strong foundations though its three compulsory subjects in programming, machine learning and optimization/operations research. Additionally, students can further specialise in 2 more electives.

Compulsory:

- *Programming for Business Applications 1*: Introduction to programming and algorithms using Python. Familiarity with divide and conquer in algorithmic problem solving. Use standard Python IDEs and package managers (pip). Introduction to basic programming constructs and data structures, simple I/O. Numerical programming with numpy/scipy, optimization and data processing (pandas), advanced analytics (scikit-learn). Assessment is based on participation and an oral exam (50%). Both parts only sum-up to 70% instead of 100%. Additionally, it is unclear if solely course participation and an oral exam are sufficient tools to assess programming skills.

- *Introduction to Machine Learning in Business*: Learn how to extract value from economic data using machine learning models. Familiarity with the following model families: (linear) regression, nearest neighbours, decision trees, random forests and neural networks. Practical exercises are done in Python based on economics use cases: economic growth prediction, real estate price estimation, stock market trend prediction, loan default prediction. Assessment is based on a case study and participation (pre-exam) and a final written- and oral exam.

- *Optimization and Business Decision-Making*: The objective of this course is to give an introduction to operations research and optimization. Students shall be able to solve real-world optimization problems and derive valid conclusions/management decisions. The course uses Python with the PuLP and Pyomo packages to solve linear programming optimization problems. Alternatively, MS Excel and Visual Promethee are used. The course is graded based on (pre-exam) a paper work-case study, colloquium and participation. A written exam and a project presentation are used for final assessment.

Elective (selection):

- *Marketing Intelligence*: The course aims to introduce marketing research methods to students to make better management decisions. Skills acquired include sampling, statistical analysis and tests, multivariate analysis and clustering, among others. Practical course work is conducted using either the Python or R programming language. Course assessment is based on colloquium, a paper on a case study and participation followed by a final project presentation.

- *Mathematics and Statistics in Business Analysis*: Students get introduced to mathematical concepts and methods including linear algebra and analysis. Additionally, the course introduces students to probability theory and statistics like statistical inference, ANOVA, chi-square tests regression and correlation analysis. The course also includes practical course work on the computer to solve related problems. Pre-exam assessment is done based on a colloquium, a case study and participation. The final grading is based on the project presentation (50%).

The electives also contain the courses Research Design and Data Visualisation Techniques and Fundamentals of Accounting and Business Finance although the course descriptions were missing from the evaluation materials.

Second Semester

The second semester has a strong focus on quantitative finance in its compulsory courses. The elective courses cover a wider range in areas such as programming, big data and web analytics.

Compulsory:

- *Time Series Forecasting*: This course on time series forecasting is aimed at students with preliminary knowledge in statistics and covers the entire time series analysis workflow. Students learn how to transform data into time series objects, visualise data and evaluate appropriate models for forecasting. Popular forecasting models like ARIMA and exponential smoothing are used. Also more sophisticated models based on neural networks are presented during the lecture. For practical course work and creation of forecasting models the R programming language is applied. The final grading is based on a project presentation (50%), pre-exam activities including colloquium, case study and participation are also included.

- *Applied Econometrics:* Throughout this course students are trained on classical econometric models and their applications on business problems. After finishing the course students shall be able to reach valid conclusions using economic methods independently. In addition to regression analysis students are also analysing panel data. For surveys they will also be able to analyse models with discrete dependent variables including multiple choice models. Grading is based on a final written exam. Additionally, a case study, colloquium and participation is included in the pre-exam phase.

- *Quantitative Finance:* This course aims to enable students to analyse financial markets including bonds, stocks and derivatives. Students learn about the types of financial instruments, working with financial data sources and vendors. It also covers basic concepts including bond valuation (including duration), capital asset pricing model and portfolio optimization and option pricing theory. Practical assignments/exercises are recommended to be done in groups and use the Python programming language. Besides participation (20%) it is currently unclear how the rest of the course (80%) is graded.

Elective:

- *Programming for Business Applications 2*: This course covers advanced programing techniques for statistical analysis using the R programming language. It introduces students to the programming language including data- and control structures and statistical tools including linear regression, hypothesis testing, ANOVA and data visualisation. RStudio is recommended as an integrated development environment (IDE), however, it is unclear why PyCharm is recommended as well, since it is primarily used for Python programming. In addition to the book R for Data Science as standard literature students shall also be familiarised with RMarkdown for report writing. Grading is based on

an oral exam (50%). However, combined with pre-exam participation (20%) these elements do not sum-up to 100%.

- *Advanced Big Data Analytics*: Use R and Python for Big Data analytics and reveal interesting insights using clustering, classification and time series analysis. Technologies such as PySpark, MapReduce and Hadoop are used to parallelize computations over a potentially large computing cluster. Practical exercises take place in the computing centre. Graded pre-exam activities include a colloquium, case study and participation. The course is finally graded through a written exam, valued at 50%.

- *Online Business and Web Analytics*: Course aims to introduce students working in online businesses to use web analytics and social media to improve business performance. Provided course description is incomplete and needs to be updated.

- *Data Acquisition in Business Intelligence*: This highly relevant course teaches students how to extract and transform data from various sources including SQL, XLS MongoDB, Hive and HTML. Programming languages used in this module include R and Python and related packages. Pre-exam activities are valued at 50% including colloquium, case study and participation. The course is finally graded through a written exam (50%). The course is hands-on taught in a computer classroom with practical examples.

- *Academic Writing*: Introduction to academic research methodology and writing. After finishing the course students will be able to write academic papers. Critical reasoning about academic content is emphasised. Students shall be able to efficiently summarise academic articles and avoid plagiarism when writing their own papers. Practical activities include reading- and writing assignments during the semester. Additionally, the course is graded based on a written exam.

Third Semester

The focus of the third semester is the internship at a company where students can apply their skills in real settings (10 ECTS). Each company should have dedicated mentors which are in close contact with students. Additionally, students are supposed to write their master's thesis (valued at 20 ECTS). It would make sense to combine the internship and thesis writing so that students have more focus on the thesis topic and hands-on experience at the same time.