HSLU Lucerne University of Applied Sciences and Arts

Master of Science in Applied Information and Data Science

Module Descriptions

Analysis of Social Interactions

Module description	
Module code	W.MSCIDS_AMS03.19
Module name	Analysis of Social Interactions
Most recent change	January 2023
Module concept	We live in a hyper-connected world, which means that everything is essentially linked to everything else through a global network that influences all aspects of life. This module will help students to understand the relations among individuals in society by focusing on the central concepts of social network analysis when applied to mining interaction data. The theoretical concepts learned in the first half of the course will be put into practice by students in their own research projects in the second half of the course. Guidance and coaching will be provided by the lecturers on finding a sensible research question that uses social network data; peer and lecturer feedback will be provided frequently on the process of coneptualisation and analysis.
Module type	Elective Module – Advanced Analytics and Big Data
Form	Regular Course (weekly)
ECTS credits	3 ECTS Credits
Teaching language	English
Head	Isabel Raabe
Adjunct lecturers	Mark Rowan

Module positioning	
Admission requirements	Data Collection, Integration and Preprocessing (W.MSCIDS_CIP02.18) Or alternatively Web and Data Scraping with R (W.MSCIDS_WDS02.20)
Recommended semester	3rd Semester
Remarks	None

Module objectives	
Overall objective	Students should learn the main concepts of social network analysis, and understand how to use the corresponding toolsets to effectively tackle the quantitative description and modelling of social interactions in a research project.
Objective: **Professional skills**	Design and carry out a data science project using social network analysis Understand the requirements of a research design to answer a specific research question Characterize entities and relations in a social system as components of a social network

	Use modern tools of data mining and network analysis to capture the structure and dynamics of a social system
Objective: **Problem-solving and critical thinking**	Students should be able to analyze and answer complex questions about the structure and dynamics of social networks. They should also be able to assess the strengths and weaknesses of their work.
Objective: **Method skills**	Understand and apply core concepts of network analysis on social interaction data using Python.
Objective: **Communication skills**	Students should be able to present their work in front of an attentive audience. They should be able to formulate and communicate a complex problem about social interactions clearly, using concepts and methods from social network analysis. They should be able to motivate and abstract their research to real-world problems.
Objective: **Interpersonal skills**	Students should be critical and cooperative to work with others on real-life social network problems.

Contents	
Topic 1: Core concepts and methods	- Introduction to social complexity - Introduction to social networks - Basic network structures and theories - Data querying, scraping, cleaning, mining - Visualizing networks
Topic 2: Application	- Project work: How to design a scientifically sound data science project - Acquiring and modelling of social network data - Report on and presentation of results

Teaching and learning		
Coursework:	**Hours**	**Hours (%)**
Contact hours	30 hrs	33%
Group project work	30 hrs	33%
Self-study	30 hrs	33%
Other		
Total	**90 hrs**	**100.0%**

Details on teaching and learning methods:

Teaching and learning methods: **Classroom**	Presentation of core notions through lectures and interactive discussion

Teaching and learning methods: **Coaching**	Guided exercises using Jupyter Notebooks and NetworkX
Teaching and learning methods: **Self-study**	Group project work and reading background material
Teaching and learning methods: **Other**	n/a

Assessments (Adaptions are possible at any time.)			
Assessments	**Assessment 1**	**Assessment 2**	**Assessment 3**
Type of performance record	Mid-term exam	Self-assessment	Final report
Evaluation type	Grade	Grade	Grade
Scope	Contents of first two lectures	Work in progress report	Final report on group project
Date	Mid-term (date to be confirmed in first session)	Second to last lecture	Deadline after lectures have ended
Weighting (if two assessments)	30%	10%	60%
Aids/materials	none	none	none

Notes on the assessments:

Language	English
Certificates	n/a
Attendance	80% attendance requirement

Teaching material	
Literature	Slides with methodological requirements and optional further readings will be handed out to students at the beginning of the semester.
Lecture notes	n/a
Online resources	Datacamp

Software	Sample scripts and exercises (Python/Jupyter notebooks)
Other resources	n/a

Applied Machine Learning and Predictive Modelling 1

Module description	
Module code	W.MSCIDS_MPM02.18
Module name	Applied Machine Learning and Predictive Modelling 1
Most recent change	June 2023
Module concept	Machine learning is a collective term for various tools that can be used to discern relationships from existing data and to predict results. In this connection, a distinction is made between supervised learning and unsupervised learning. Supervised learning is based on statistical models for predicting or estimating a result by means of one or more input variables. This method lends itself to solving problems in areas such as economics, medicine, astrophysics and politics. Unsupervised learning, on the other hand, does not produce any examples of "correct" or "expected" outcomes, although relationships and connections can be identified from such data. The module focuses on methods of supervised learning and illustrates them with applied examples taken from real-life situations for the purpose of making predictions. Finally, important methods of unsupervised learning are discussed. In this module, students learn to apply supervised learning in practice and to understand its basic principles of unsupervised learning.
Module type	Required module
Form	Regular course
ECTS credits	3 ECTS Credits
Teaching language	English
Head	Matteo Tanadini
Adjunct lecturers	Daniel Meister, Luisa Barbanti

Module positioning	
Admission requirements	Classical and Bayesian Statistics (W.MSCIDS_SA01.18)
Recommended semester	2nd semester
Remarks	None

Module objectives	
Overall objective	Students learn the basic techniques, tools and approaches relating to machine learning while under the supervision of an expert. They will work on examples from the applied fields, whereby they can practice the methods and gain first experiences in making forecasts. Students are able to select suitable methods for a particular problem, apply them to real-life sample data, and evaluate the results.
Objective: **Professional skills**	Students know the basic procedures of supervised learning (regression, classification, decision trees, support vector machines, resampling, model selection and regularization) and gain an initial understanding of unsupervised learning methods (principal component analysis, clustering). They are able to evaluate whether the methods are suitable for solving problems as found in practice.
Objective: **Problem-solving and critical thinking**	Students are able to identify appropriate methods for solving a new analytical problem and to apply them and evaluate the results.
Objective: **Method skills**	Students are able to apply the presented methods to new data and interpret the results of the software package they used.
Objective: **Communication skills**	Students are able to communicate appropriately their approach when selecting methods and doing the analysis, and they can present their results to a particular audience effectively.
Objective: **Interpersonal skills**	Students are able to develop problem-solving strategies for machine learning problems in a team, select and conduct various analyses, and evaluate the results jointly.
Objective: **Personal skills**	None

Contents	
Topic 1: **Linear Regression**	Application of single regression and multiple linear regression (based on the linear regression in Module 05.01)
Topic 2: **Generalised Linear Models**	GLMs will be introduced with a focus on classification and modelling of count data
Topic 3: **Extensions to Linear Regression and to Generalised Linear Models**	Modelling non-linear effect via polynomials and Generalised Additive Models
Topic 4: **Support Vector MachineResampling**	Support Vector Machines(Cross-)
Topic 5: **Neural Network**	Neural Networks

Topic 6: **Agent-based Modelling**	Approximate Bayesian Computation
Topic 7: **Approximate Bayesian Computation**	- Maximal Margin Classifier - Support Vector Classifiers - Support vector machines
Topic 8: **Model Validation**	Fundamental concepts of model validation are introduced

Teaching and learning

Coursework:	**Hours**	**Hours (%)**
Contact hours	16 hrs	17.78%
Coaching	12 hrs	13.33%
Self-study	40 hrs	44.44%
Other	22 hrs	24.45%
Total	**90 hrs**	**100.0%**

Details on teaching and learning methods:

Teaching and learning methods: **Classroom**	Discussion-based lessons with examples Presentation
Teaching and learning methods: **Coaching**	Exercises completed with a coach and independently
Teaching and learning methods: **Self-study**	None
Teaching and learning methods: **Other**	Student projects with real-life tasks

Assessments

(Adaptions are possible at any time.)

Assessments	**Assessment 1**	**Assessment 2**
Type of assessment	Written examination	Possible projects or exercises
Evaluation type	Grades	Pass/Fail
Scope	60 minutes	NN

Dates	During the official examination period	Work during the semester; submission at the end of the semester
Weighting (if two assessments)	60%	40%
Aids/materials	Closed book, own summary allowed	None

Notes on the assessments:

Language	German or English (free of choice)
Certificates	None
Attendance	None

Teaching materials	
Literature	No mandatory teaching aids. Recommended: - Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani. Introduction to Statistical Learning with Applications in R, Springer 2017
Lecture notes	None
Online resources	Recommended: - Coursera course on Machine Learning by Andrew Ng: https://www.coursera.org/learn/machine-learning
Software	R with RStudio
Other resources	None

Applied Machine Learning and Predictive Modelling 2

Module description	
Module code	W.MSCIDS_MPM03.19
Module name	Applied Machine Learning and Predictive Modelling 2
Most recent change	June 2023
Module concept	Machine learning has the goal to learn from data and predict future results. A distinction is made between supervised learning and unsupervised learning. Supervised learning is based on models algorithms for understanding and predicting the relationship between a response (=label) variable and a set of predictor variables. These methods have applications in areas such as economics, medicine, astrophysics and politics. Unsupervised learning, on the other hand, does distinguish between a response variable and predictor variables but rather tries to find patterns and structur in a collection of variables. I.e., relationships and structures can be derived from the data. The module focuses on modern methods of both supervised and unsupervised learning and illustrates these methods with example applications based on real problems for prediction. In this module, students learn to understand the principles of modern machine learning and apply advanced supervised and unsupervised learning in practice.
Module type	Required module
Form	Regular Course (weekly)
ECTS credits	3 ECTS Credits
Teaching language	English
Head	Oliver Staubli
Adjunct lecturers	tbd

Module positioning	
Admission requirements	Applied Machine Learning and Predictive Modeling 1 (W.MSCIDS_MPM02.18)
Recommended semester	3rd semester
Remarks	Exercises in R and Python

Module objectives	
Overall objective	Students learn the basic techniques, tools and architectures of modern machine learning with. In application examples, students can practice the procedures and gain experience in the application of methods such as random forest, boosting, clustering, multidimensional scaling, and principal component analysis. Students can select suitable methods for practical questions, process them on real example data and evaluate the results obtained.
Objective: **Professional skills**	Students - know the basic procedures of machine learning methods (principal component analysis, dimension reduction, multidimensional scaling, clustering, classification methods, trees, random forest, boosting and others.) - can assess the suitability of the learned methods to solve a practical problem.
Objective: **Problem-solving and critical thinking**	Students can identify adequate methods to solve problems, apply them and evaluate the results.
Objective: **Method skills**	Students can apply the presented methods to new data and interpret the results of the software package used.
Objective: **Communication skills**	Students can describe their approach to choose a given method as well as the results of their analysis with an adapted language that takes into account the recipient audience.
Objective: **Interpersonal skills**	Students are able to design strategies to solve machine learning problems, select among different analysis methods, carry them out and evaluate the results together in groups
Objective: **Personal skills**	None

Contents	
Topic 1: **Dimensionality reduction**	- Principal Component Analysis (PCA)
Topic 2: **Multi-dimensional Scaling (MDS)**	- Classical MDS - Non-metric MDS - t-Distributed Stochastic Neighbor Embedding (t-SNE) - ISOMAP
Topic 3: **Clustering**	- K-means - Partitioning around medoids (PAM) - Hierarchical clustering - DBSCAN

Topic 4: **Classification**	- Logistic regression - Evaluating and comparing classifiers
Topic 5: **Trees and ensemble methods**	- Regression and classification trees - Random forest - Boosting

Teaching and learning

Coursework:	**Hours**	**Hours (%)**
Contact hours	20 hrs	22.3 %
Coaching	30 hrs	33.3%
Self-study	40 hrs	44.4%
Other		
Total	**90 hrs**	**100.0%**

Details on teaching and learning methods:

Teaching and learning methods: **Classroom**	Interactive lessons (active-learning).
Teaching and learning methods: **Coaching**	Exercises or student projects with real data analysis.
Teaching and learning methods: **Self-study**	Module Wiki
Teaching and learning methods: **Other**	None

Assessments

(Adaptions are possible at any time.)

Assessments	**Assessment**
Type of assessment	Written examination
Evaluation type	Grades
Scope	60 minutes
Dates	During the official examination period
Weighting (if two assessments)	100%

Aids/materials	Closed book, own summary of maximally 8 A4 pages permitted.

Notes on the assessments:

Language	English (Answers in German allowed)
Certificates	None
Attendance	None

Teaching materials

Literature	No compulsory book; however, recommended books are: - Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani. Introduction to Statistical Learning with Applications in R, Springer 2017 - Trevor Hastie, Robert Tibshirani. The Elements of Statistical Learning, Springer 2008
Lecture notes	In module Wiki
Online resources	Recommended: - Coursera Course Machine Learning by Andrew Ng: https://www.coursera.org/learn/machine-learning
Software	R or/and Python
Other resources	None

Big Data in the Cloud

Module description	
Module code	W.MSCIDS_BDL03_2.19
Module name	Big Data in the Cloud
Most recent change	October 2021
Module concept	The module is a direct continuation of the preceding modules and consolidates knowledge gained so far about using Python and databases. It includes various lab tasks to enhance the understanding, usage and also configuration of the Azure Data infrastructure. End to End usage from database to the actual application will allow the students to experience every touchpoint of the big data chain. Finally, the business part will enhance the value proposition allowing the participants to create a full project offering including the Delivery, Lifecycle and SLA perspective.
Module type	Core Elective Module – Advanced Analytics and Big Data
Form	Block Seminar on site (Tue/Wed/Thu) and online (Mon/Fri) (autumn semester: Feb. / spring semester: Aug. or Sept.)
ECTS credits	3 ECTS Credits
Teaching language	English
Head	Dimitrios Marinos
Adjunct lecturers	Koen Tersago, Tomas Marek

Module positioning	
Admission requirements	Data Collection, Integration and Preprocessing (W.MSCIDS_CIP02.18) Database Management for Data Scientist (W.MSCIDS_DBM02.18) recommended: NoSQL Lab with Python & MongoDB (W.MSCIDS_BDL03.1.22)
Recommended semester	3rd semester
Remarks	The module is offered as a block week. The module focuses on creating awareness and hands-on knowledge on a real big data infrastructure environment while providing a holistic view on big data projects from offering to delivery stages.

Module objectives	
Overall objective	Students learn how to use current big data tools such as the entire Azure Data Factory chain, SQL, Python and Dashboarding (power BI or Tableau).
Objective: **Professional skills**	Students can configure, leverage, and interact with a given data lake structure and perform actions of data clearance and manipulation. Students will be introduced to the Azure environment and become familiar with the big data infrastructure elements while being able to configure and interact with some of them. Students will be able to interact with the big data lake given by the tutors using Python and finally project the data story on a dashboarding tool e.g. Power BI or Tableau.
Objective: **Problem-solving and critical thinking**	Students can determine which of the big data architecture is adequate for the requirements of a HSLU given project scope, deploy it and write a full offering package with pricing, lifecycle, and SLA coverage.
Objective: **Method skills**	Students will practice how to use the Azure and SQL for large data volume along with interactions using Python. Students will learn how to structure big data projects, deploy, price, and roll them out.
Objective: **Communication skills**	Each team will have to present their big data project.
Objective: **Interpersonal skills**	Students will work together to complete a series of lab exercises.
Objective: **Personal skills**	Presentation skills, negotiation attitude, technical judgement.

Contents	
Topic 1: Big Data in Business	• Understand the customer's (or our) big data requirements • Be able to compile offerings on big data projects based on market needs
Topic 2: Data Handling	• Use of cloud databased structures for big data repositories • Work hands on data lakes • Manipulate and clear the big data content and present a data map architecture
Topic 3: Cloud Colverage	• Leverage Azure for use with big data requirements • Learn the data factory and databricks principles

	• Configurate and setup full big data instance
Topic 4: Data handling	• Write Python to access and work on real data • Present them valuably on power BI or Tableau dashboard • Create a full deployment concept and offering from pricing to SLAs.

Teaching and learning		
Coursework:	**Hours**	**Hours (%)**
Contact hours (in a block week)	30 hrs	33%
Coaching	0 hrs	0%
Self-study	50 hrs	56%
Other	10 hrs	11%
Total	**90 hrs**	**100.0%**

Details on teaching and learning methods:

Teaching and learning methods: **Classroom or Online**	The lectures focus closely on the principles of Topics 1, 2, 3 and 4. Students will complete various lab exercises during class, discuss and develop solutions for some of them in small groups.
Teaching and learning methods: **Coaching**	Will be given during the lab and exercises.
Teaching and learning methods: **Self-study**	The lecturers will guide the students throughout the entire Big Data journey step by step. Students will need to study a documentation and install available online software in advance.
Teaching and learning methods: **Other**	During the lab the students will work on real case exercises.

Assessments (Adaptions are possible at any time.)		
Assessments	**Assessment 1**	**Assessment 2**
Type of assessment	Submission of a lab project	None
Evaluation type	Grade	None

Scope	The last half day of the lab.	None
Dates	During the block seminar - according to the lecturer's information	None
Weighting (if two assessments)	100%	None
Aids/materials	No restrictions, except that it must be the author's original work.	None

Notes on the assessments:

Language	German or English (free of choice)
Certificates	None
Attendance	Yes, the module is offered as a single block week.

Teaching materials	
Script	None Various exercises
Online resources	Communicated during the classes
Software	Azure, Visual Code, Power/BI and/or Tableau, MySQL workbench
Other resources	Communicated during the classes

Classical and Bayesian Statistics

Module description	
Module code	W.MSCIDS_SA01.18
Module name	Classical and Bayesian Statistics
Most recent change	June 2021
Module concept	Inadequate data analysis can result in non-existing correlations being accepted or the correlations being over- or underestimated, as well as other faulty conclusions being drawn. Mathematics offers rigorous methods that, if applied consistently, help to avoid such errors, and it summarizes them in its "statistics" sub-discipline. This module discusses these mathematical methods with regard to the handling of big data. The Bayesian approach to statistics has become more important in recent years and will be discussed extensively but the classical approach will still play an important role. Both approaches will be compared with each other. As a second focus of this module, the statistics software R is a powerful tool for working with these methods.
Module type	Required Module
Form	Regular Course (weekly)
ECTS credits	6 ECTS Credits
Teaching language	English
Head	Peter Büchel
Adjunct lecturers	None

Module positioning	
Admission requirements	None
Recommended semester	1st semester
Remarks	None

Module objectives	
Overall objective	Students are able to answer specific questions about data sets when completing tasks of medium difficulty.
Objective: **Professional skills**	Students - are able to test hypotheses - are able to model and analyze data by means of regression models, which they are able to carry out. - are able to build models in the Bayesian context.

	Students understand regression models as the basis for modeling and analyzing data (basis for the advanced modules). Students are able to verify the plausibility of statistical statements in reports and whether the methods used are adequate.
Objective: **Problem-solving and critical thinking**	Students - understand the situations in which hypothesis testing is appropriate. - are able to decide which test to use.
Objective: **Method skills**	Students - are able to apply the steps they have learned to a specific context. - are able to solve problems using the software R. - are able to interpret the outputs of the statistics software R.
Objective: **Communication skills**	Students are able to describe their model and analysis to a customer or third party appropriately and are able to communicate the results of their inquiry effectively.
Objective: **Interpersonal skills**	
Objective: **Personal skills**	Students are open to having their own results reviewed critically and to examining them from other perspectives.

Contents	
Topic 1: **Introduction to R based on examples**	Exploratory data analysis
Topic 2: **Introduction to probability theory**	Fundamentals of probability theory Probability distributions (general, normal distribution, t-distribution)
Topic 3: **Hypothesis testing**	Tests for specific distributions (t-test, Wilcoxon test)
Topic 4: **Regression models**	Simple linear regression Multilinear regression
Topic 5: **Introduction to the Bayesian thinking**	Bayes Theorem Introducing statistical models using Bayesian techniques Comparing classical to Bayesian statistics.

Teaching and learning		
Coursework:	**Hours**	**Hours (%)**
Contact hours	30 hrs	33.3%
Coaching	30 hrs	33.3%

Self-study	30 hrs	33.3%
Other		
Total	**90 hrs**	**100.0%**

Details on teaching and learning methods:

Teaching and learning methods: **Classroom**	Discussion-based lessons with examples Presentation
Teaching and learning methods: **Coaching**	Exercises with tasks taken from real life
Teaching and learning methods: **Self-study**	None
Teaching and learning methods: **Other**	None

Assessments

(Adaptions are possible at any time.)

Assessments	**Assessment 1**	**Assessment 2**
Type of assessment	Online test	Written examination
Evaluation type	Grades	Grades
Scope	Questions concerning the exercises	60 min., plus 30 min. for technical preparation
Dates	During the semester (2 dates)	During the official examination period
Weighting (if two assessments)	30%	70%
Aids/materials	None	Own summary

Notes on the assessments:

Language	German or English (free of choice)
Certificates	None
Attendance	None

Teaching materials

Literature	Deborah J. Rumsey, Statistics for Dummies

Lecture notes	Yes
Online resources	www.datacamp.com
Software	R with RStudio Download R: https://stat.ethz.ch/CRAN/ Download RStudio: https://rstudio.com/products/rstudio/download/#download
Other resources	Slides

Collaborative Innovation Networks

Module description	
Module code	W.MSCIDS_NET02.22
Module name	Collaborative Innovation Networks
Most recent change	January 2023
Module concept	Experience for yourself how connectedness leads to happiness, beauty, and creativity. This research seminar consists of two parts: 1. Connectedness 2. Creativity through beauty **Connectedness** – In an initial admission workshop, participants will get connected in hybrid mode, co-located at the local participating institutions (HSLU, U. Cologne, U. Bamberg, LUT, UPM), to learn the foundational technologies of **Happimetrics** for the second, teamwork part. **Beautiful Creativity** – form a small team, a COIN or Collaborative Innovation Network, to create something beautiful! Combine cutting-edge research in AI, human dynamics, biotechnology, music, and architecture together with leading scientists from around the world to develop new solutions for increased wellbeing. Participants will join active research projects - to further the state of the art of positive psychology, using latest advances of AI and SNA, and combining it with biology and architecture. Participants will work together with researchers and practitioners in the field. The result of the seminar will be new software and hardware solutions, as well as scientific publications.
Module type	General core elective module
Form	External Course
ECTS credits	6 ECTS Credits
Teaching language	English
Head	Peter Gloor
Adjunct lecturers	None

Module positioning	
Admission requirements	- Applied Machine Learning and Predictive Modelling 1 (W.MSCIDS_MPM02.18) - Data Collection, Integration and Preprocessing (W.MSCIDS_CIP02.18)
Recommended semester	None
Remarks	None

Contents

This seminar applies Happimetrics to track emotions between humans, and humans and other species (plants, animals). It uses AI to analyze interaction among humans – from online social media to body sensing - and predicting their emotions through machine learning. Knowing what makes you happy will make you happier! Analyzing people's communication patterns and making them self-aware by mirroring their behavior back to them in a privacy-respecting way will increase individual happiness and team performance.
Happimetrics takes three steps to building happiness and better performance through groupflow, starting with how to create happiness by analyzing communication, how to measure happiness, and how to optimize communication for more happiness and better teamwork by mirroring back the measurements to the individual.

1. Understand the basic concepts of groupflow – when teams collaborate at their best through intrinsic motivation and positive stress
2. Understand how analyzing your own communication behavior through virtual mirroring increases business performance and individual satisfaction
3. Understand how to build "entangled" teams by measuring synchronicity among team members using AI, SNA (social network analysis), and time series analysis.

Features for machine learning can be computed in 6 different ways:

1. Social network analysis – Griffin, SocialCompass
2. Natural language processing – tribes, BERT for emotions
3. Face emotion recognition – Moody, individual faces
4. Voice emotion recognition – MFCC, pyaudioanalysis
5. Body signal emotion recognition - happimeter smartwatch
6. Plant sensor emotion recognition – BYB plant spikerbox

Happimetrics is based on 20 years of research from our MIT Collaborative Innovation Networks (COIN) project on leadership, creativity, team building, and positive psychology published in over 250 peer-reviewed scientific papers and hundreds of industry and research projects our team conducted on individual and organizational creativity and performance.

Teaching and learning

Coursework:	**Hours**	**Hours (%)**
Contact hours	20 hrs	20%
Coaching/teamwork	40 hrs	40%
Self-study	80 hrs	40%
Other		
Total	**140 hrs**	**100%**

Details on teaching and learning methods:

Teaching and learning methods: **(virtual) Classroom**	Discussion-based lessons, presentations by teacher (20%) and students (80%)
Teaching and learning methods: **Coaching/teamwork**	Select project and work in a team with 2 to 5 members to apply the methods learned in the (virtual) classroom

Teaching and learning methods: **Self-study**	After dividing the work among team members, work independently on completing the assigned tasks, supported by instructor and team members.
Teaching and learning methods: **Other**	

Assessments
(Adaptions are possible at any time.)

Assessments	**Assessment 1**	**Assessment 2**
Type of assessment	Presentation of material in Happimetrics manuscript Presentation of own email virtual mirror and Twitter/social media Griffin analysis	Group project (in groups of 2 to 5): Analysis of the chosen team project from https://sites.google.com/view/coinseminar23/projects For the bi-weekly status meetings scrum is used, the structure of the presentation is listed here: https://www.dropbox.com/s/l81aei2nkftabhb/Tips%20for%20groupwork_COINs21.pdf?dl=0
Evaluation type	Grades	Grades
Scope	Presentation of 5-10 minutes, plus discussion	Presentation of 5-10 minutes, plus 5 min. to answer questions Quality of slides according required presentation structure, quality of data analysis and software solution
Dates	https://sites.google.com/view/coinseminar23/dates	
Weighting (if two assessments)	20%	80%
Aids/materials	https://sites.google.com/view/coinseminar23/materials	

Notes on the assessments:

Language	English
Certificates	None
Attendance	90% (in virtual status meetings)

Teaching materials

Literature	https://sites.google.com/view/coinseminar23/materials

Lecture notes	Happimetrics manuscript https://www.dropbox.com/s/9vgt7rhzz7m9twz/Happimetrics_v26s.pdf?dl=0 www.happimetrics.com
Online resources	https://sites.google.com/view/coinseminar23/
Software	Griffin, SocialCompass, GalaxyScope, Python and Keras, R
Other resources	None

Computational Language Technologies

Module description	
Module code	W.MSCIDS_CTA03.19
Module name	Computational Language Technologies
Most recent change	June 2023
Module concept	A large part of business information is only available as unstructured text data. This represents a challenge for computational processing. The analysis of text data has triggered the development of specialized methods at the intersection of Linguistics, Computer Science, and Machine Learning. These are commonly referred to as Natural Language Processing (NLP). NLP powers - among many other applications - information extraction from text, sentiment analysis, automatic text summarization, machine translation, speech recognition, text classification, and virtual assistants. This module introduces the main building blocks of a text understanding pipeline. It focuses on techniques applicable in a business context. In the first part of the course, we will learn how to access and analyze textual resources, discover interesting patterns, extract relevant information from text data. In the second, we will be focusing on deep learning in NLP and scratch the surface of recent advances in foundation models. Students will gain a foundational understanding in NLP methods and strategies. They will also learn to identify the strengths and weaknesses of the various technologies and frameworks. Speech-to-text and text-to-speech will not be covered in this course.
Module type	Core Elective Module – Advanced Analysis and Big Data
Form	Regular Course (weekly)
ECTS credits	3 ECTS Credits
Head	Dr. Diego Antognini
Adjunct lecturers	

Module positioning	
Admission requirements	- Applied Machine Learning and Predictive Modelling 1 (W.MSCIDS_MPM02.18) - Data Collection, Integration and Preprocessing (W.MSCIDS_CIP02.18)
Recommended semester	3rd semester
Remarks	

Module objectives	
Overall objective	Students can build the main components of a Natural Language Processing pipeline and can apply the learned methods in various use cases. They are capable of presenting and visualizing analyses and findings in an informative and structured manner.
Objective: **Professional skills**	Founded knowledge in the areas: - Pre-processing - Full-text search - Bag-of-words model - Document classification - Word embeddings - Language models - Keyword extraction - Semantic analysis - Information extraction - Basics of neural networks and deep learning for NLP - Named entity recognition - Text summarization
Objective: **Problem-solving and critical thinking**	
Objective: **Method skills**	
Objective: **Communication skills**	
Objective: **Interpersonal skills**	
Objective: **Personal skills**	

Contents	
Topic 1	*Introduction to Natural Language Processing Pipeline & Linguistic Concepts* The main NLP methods and common NLP tasks will be introduced. Benefits and challenges of NLP are discussed. We are going to refresh fundamental linguistic concepts and introduce an analytics pipeline to gain information from text. We will learn how to extract Named Entities from text.
Topic 2	*Text Processing & Exploratory Text Analysis* Focus of this block is on data discovery. We will learn how to scrape semi-structured data from Wikipedia. Text pre-processing and normalization will be discussed and practiced. Exploratory text analysis is introduced, including summary statistics and data discovery. Text visualization skills will be refreshed/learned. We will build a naïve Recommender and introduce Sentiment analysis.

Topic 3	*Representation learning* Focus of the session is to obtain the ability to transform text into computer readable representations. We will learn about discrete and distributed vector representations and practice the transformation techniques. We will also train our very own, domain specific word embeddings.
Topic 4	*Similarity & Classification* This session focusing on the understanding of core similarity/distance measures and their applicability. We will apply the learned techniques to build our first Text classification models. Evaluation of these models will be also a center of this session. We will also start introducing basic concepts of Deep Learning for NLP.
Topic 5	*Deep Learning in NLP* Basic concepts of Deep Learning for NLP will be introduced with a focus on CNN and RNN. Named entity recognition and Text classification will be practiced.
Topic 6	*Deep Learning in NLP* We move into more advanced concepts of Deep Learning for NLP with a focus on attention mechanisms and Transformers. Current practice with foundation models will be introduced. Translation and Text-style transfer will be practiced.
Topic 7	*Deep Learning in NLP* We move into more advanced concepts of Deep Learning for NLP with a focus on attention mechanisms and Transformers. Current practice with foundation models will be introduced. Translation and Text-style transfer will be practiced.

Teaching and learning

Coursework:	**Hours**	**Hours (%)**
Contact hours	30 hrs	33.3%
Coaching	30 hrs	33.3%
Self-study	30 hrs	33.3%
Other		
Total	**90 hrs**	**100.0%**

Details on teaching and learning methods:

Teaching and learning methods: **Classroom**	
Teaching and learning methods: **Coaching**	

Teaching and learning methods: **Self-study**	
Teaching and learning methods: **Other**	

Assessments (Adaptions are possible at any time.)		
Assessments	**Assessment 1-2-3**	**Assessment 4**
Type of assessment	Hands-on exercises	Take-home test (online)
Evaluation type	Grades	Grades
Scope		
Dates	During the semester - according to the lecturer's information	During the semester - according to the lecturer's information
Weighting	75%	25%
Aids/materials	Any	Any

Notes on the assessments:

Language	English
Certificates	None
Attendance	None

Teaching materials	
Literature	Charu C. Aggarwal: Machine Learning for Text, Springer (2018) S. Bird, E. Klein, E. Loper: Natural Language Processing with Python, O'Reilly (2009)
Lecture notes	Will be provided after each class.
Online resources	D. Jurafsky, J. H. Martin: Speech and Language Processing (3rd ed. draft), https://web.stanford.edu/~jurafsky/slp3/
Software	Python and common NLP-Packages. A detailed list will be made available at the beginning of the course.
Other resources	

Computer Science Concepts for Data Scientists

Module description	
Module code	W.MSCIDS_CSC01.18
Module name	Computer Science Concepts for Data Scientists
Most recent change	July 2020
Module concept	Information systems – including big data and all associated tasks – can never be anything other than hardware and software, both of which we encounter in virtually all aspects of modern life. Nevertheless, there are basic principles that play a key role in the design of these two components. This module examines these principles using examples (e.g. carrying out own analyses or manipulations with selected methods and IT tools). The topics and contents are carefully selected with a view to developing them further in the subsequent modules.
Module type	Required module
Form	Regular Course (weekly)
ECTS credits	3 ECTS Credits
Teaching language	English
Head	Martin Zimmermann
Adjunct lecturers	Halldor Janetzko

Module positioning	
Admission requirements	None
Recommended semester	1st semester
Remarks	None

Module objectives	
Overall objective	Understand, describe and evaluate computer systems and networks in terms of their components and function; classify and describe application architectures; understand and be able to apply the basic concepts of data modeling and data processing by using current tools and operating systems.
Objective: **Professional skills**	Understand the basic structure of computer systems, the essential components and the tasks and functions of operating systems; describe how networks are designed and function by using the internet as an example, and to apply some general concepts; Understand the principles of virtualization and cloud computing; classify and describe application architectures;

	explain the properties of algorithms and the most important data structures; understand and be able to apply the basic concepts of modern programming languages; understand and create simple data models; be able to apply data processing based on filters and pipes.
Objective: **Problem-solving and critical thinking**	Be able to examine a given computer system in terms of its components and performance data; compare various cloud systems; formulate simple algorithms and programs; integrate algorithms into a program; make the right choice for a given problem involving a rough application architecture (e.g. web application, native applications, hybrid application); create a simple data model for a given problem; create filters and pipes for data processing.
Objective: **Method skills**	Be able to independently find the necessary information for a given problem in the above-mentioned areas.
Objective: **Communication skills**	Exchange feedback with peers.
Objective: **Interpersonal skills**	Function effectively in the group.
Objective: **Personal skills**	Study the topics independently. Monitor one's own motivation levels and get suitable support as needed; manage deadlines and schedules and be able to submit project work on time.

Contents	
Topic 1: **Computer systems and networks**	Components and interfaces of computer systems Tasks and architecture of operating systems Design of networks (TCP/IP Model), several protocols Virtualization Cloud computing Case studies: Developing a network (simulation) with switches and routers,Linux as virtual machine
Topic 2: **Software**	General principles of software development Classes of applications: Web applications, native applications, From the problem to the program: Algorithms Basic concepts of programming languages Complexity of algorithms Case study: Programming with MIT App Inventor
Topic 3: **Data modeling and processing**	The principles of data modeling Big data challenges: 5 Vs Focus volume: Principles for working with big data Shell introduction: SSH, Bash, folder, editors, Man-pages Data processing in Shell: pipe, wget, cat, cut, sort, join, grep, wc, awk

	Visualization concepts and techniques in Tableau Case Study: Log file analysis

Teaching and learning		
Coursework:	**Hours**	**Hours (%)**
Contact hours	30 hrs	33.3%
Coaching	30 hrs	33.3%
Self-study	30 hrs	33.3%
Other		
Total	**90 hrs**	**100.0%**

Details on teaching and learning methods:

Teaching and learning methods: **Classroom**	Introduction to the module's design and the semester Discussion about self-study (e.g. flipped classroom) Presentation and discussion of the exercises Introduction to the project
Teaching and learning methods: **Coaching**	Guided study of the literature Group exercises Group projects
Teaching and learning methods: **Self-study**	Individual exam preparation
Teaching and learning methods: **Other**	None

Assessments (Adaptions are possible at any time.)		
Assessments	**Assessment 1**	**Assessment 2**
Type of assessment	Written examination	Project on a selected topic
Evaluation type	Grades	Grades
Scope	60 minutes	
Dates	during the official examination period	During the semester - according to the lecturer's information
Weighting (if two assessments)	66%	33%
Aids/materials	Open book BYOD with Filius, Linux-VM only for an applied task.	All legitimate aids are permitted

Notes on the assessments:

Language	German or English (free of choice)
Certificates	None
Attendance	None

Teaching materials	
Literature	Abts, D., Mülder, W., Grundkurs Wirtschaftsinformatik, 9th edition, Springer Vieweg, Berlin 2017
Lecture notes	Provided on Ilias by the lecturers
Online resources	HTML and MIT App Inventor tutorials www.mit.appinventor.edu selfhtml.org/
Software	MIT App Inventor Brackets (HTML Editor) git, bash, VirtualBox, Vagrant, Ubuntu
Other resources	Ubuntu pages

Computer Vision

Module description	
Module code	W.MSCIDS_CVI03.22
Module name	Computer Vision
Most recent change	June 2022
Module concept	Computer vision has become ubiquitous in society, and there are numerous applications in fields such as image search, medical analysis of MRI or X-rays images, drones, self-driving vehicles, face recognition e.g. in an unlocking app of a cell phone, and video surveillance. The underlying principles for many of these applications are complex image recognition processes, such as image classification, localization and the detection of objects in images. In recent years, neural networks ("deep learning") have fundamentally changed the performance of image recognition systems. In this course, students will learn how to implement, train, debug and optimize their own neural networks for various tasks in computer vision. Students are introduced to the newest methods and applications in the field of computer vision. They will be able to explain the problems related to computer vision with deep learning.
Module type	Core Elective Module – Advanced Analytics and Big Data
Form	Block seminar
ECTS credits	3 ECTS Credits
Teaching language	English
Head	Mirko Birbaumer / Umberto Michelucci
Adjunct lecturers	None

Module positioning	
Admission requirements	Deep Learning (W.MSCIDS_DPL03.22)
Recommended semester	3rd Semester
Remarks	None

Module objectives	
Overall objective	Students are able to explain, use and compare a range of deep learning methods for solving problems related to image-based object classification,

	localization and segmentation. They are able to explain the underlying algorithms and technologies of these methods, select suitable models for a given data set, and explain their choice. Furthermore, they have the necessary practical experience in solving exemplary problem tasks of varying complexity, are able to explain the possibilities and limitations of the methods used, and can apply them to new data sets. Students are able to deepen their understanding of the underlying technologies independently, follow developments in new research areas, and apply what they have learned.
Objective: **Professional skills**	Students are able to explain the essential characteristics and peculiarities of image data. They are able to display image data, store it in different formats, and process and extract specific attributes from it. Students are able to explain the theoretical principles of the most relevant deep learning methods and how they can be applied to image data sets. They are able to explain different validation methods and metrics in order to compare different models with respect to their performance, uncertainty and limitations. Students are able to interpret and explain model predictions in different contexts.
Objective: **Problem-solving and critical thinking**	Students are able to independently assess whether a computer vision problem can be solved by means of deep learning methods, select suitable deep learning methods, and apply these methods to new data sets. Students are able to explain the specific requirements, conditions and limitations of the methods used. They are able to summarize the historical development up to the latest state of research of the discipline. Students are able to reflect and evaluate their own knowledge with respect to the state-of-the-art expertise of these technologies.
Objective: **Method skills**	Students are familiar with cutting-edge tools and can apply them accurately and efficiently to solve specific problems.
Objective: **Communication skills**	Students are able to present the analysis of image data correctly, coherently and vividly to expert and lay audiences.
Objective: **Interpersonal skills**	Critical and respectful discussions in groups.

Contents	
Topic 1: Motivation and history	Typical tasks in computer vision. Representation and Processing of Images with NumPy and OpenCV: - Representation of images as Python NumPy arrays - Greyscale operations - Morphology - Modern methods for improving image quality such as denoising, compression, smoothing - Colour systems - Compression - Filters and Kernels (e.g. for edge detection, sharpening, etc.)

Topic 2: Core concepts and methods	Semantic segmentation, object localization and classification, instance segmentation - U-Net and HRnet - R-CNN, Fast R-CNN, Faster R-CNN - Yolo, RetinaNet, SDS - Mask R-CNN - Performance metrics: F1-score, dice score, intersection over union, average precision, mean average precision
Topic 3: Advanced topics	Generative Models - Autoencoders - Variational Autoencoders - Generative Adversarial Networks (GANs) - Neural Style Transfer and Deep Dreams - Transformers
Topic 4: Application	- Object detection and classification applied to movies recorded by IoT devices in a lab session. - Course project on varying state-of-the-art computer vision problem tasks and project presentation

Teaching and learning

Coursework:	**Hours**	**Hours (%)**
Contact hours	28 hrs	31.1%
Coaching	4 hrs	4.5 %
Self-study	58 hrs	64.4%
Other		
Total	**90 hrs**	**100.0%**

Details on teaching and learning methods:

Teaching and learning methods: **Classroom**	Short lectures on the theoretical concepts, followed by hands-on examples (prepared programming examples to be adapted to specific tasks) individually or in groups. Subsequent reflection through clicker tasks / quizzes, as well group as plenary discussions. IoT lab.

Teaching and learning methods: **Coaching**	Exercises for each topic.
Teaching and learning methods: **Self-study**	Projects on real-life datasets.
Teaching and learning methods: **Other**	

Assessments

(Adaptions are possible at any time.)

Assessments	**Assessment 1**	**Assessment 2**
Type of performance record	Presentation of project work	
Evaluation type	Grade	
Scope	30 min. presentation including 10 min. for discussion/questions	
Date	During the block seminar - according to the lecturer's information	
Weighting (if two assessments)	100%	
Aids/materials		

Notes on the assessments:

Language	English
Certificates	None
Attendance	None

Teaching material	
Literature	Inidicated at the end of each chapter of the lecture notes.
Lecture notes	Lecture notes will be provided.
Online resources	- Convolutional Neural Networks for Visual Recognition, http://cs231n.stanford.edu/ - Deep Learning by Goodfellow, Bengio and Courville: https://www.deeplearningbook.org
Software	Python, Keras and Tensorflow
Other resources	Advanced Applied Deep Learning, Umberto Michelucci, https://link.springer.com/book/10.1007/978-1-4842-4976-5 Applied Deep Learning with TensorFlow 2, Learn to Implement Advanced Deep Learning Techniques with Python, Umberto Michelucci, https://link.springer.com/book/10.1007/978-1-4842-8020-1

Customer Data Analytics

Module description	
Module code	W.MSCIDS_DE_CRA01.18
Module name	Customer Data Analytics
Most recent change	December 2022
Module concept	The "Domain Experience: Customer Analytics" module familiarizes students with applied data science in the context of customer data analysis. Many companies collect a broad range of customer data (e.g. transaction data, personal data, hiring data) for the purpose of analyzing customer relationships. The module initially provides an overview of the possibilities of customer analytics. Students have the opportunity to work on real-life analyses as part of a group project, where they are given a clearly defined problem, work with customer data, and receive the support they need in conducting the analysis. The lecturers of Lucerne School of Business and experts from the applied fields support the project.
Module type	Core elective module - Domain Experience
Form	Regular Course (weekly)
ECTS credits	3 ECTS Credits
Teaching language	English
Head	Dominik Georgi, Ingo Gächter
Adjunct lecturers	Lukas Stolz

Module positioning	
Admission requirements	none
Recommended semester	none
Remarks	None

Module objectives	
Overall objective	Students are able to conduct big-data analyses to contribute substantially to how customer experiences and relationships are managed.
Objective: **Professional skills**	They are able to carry out quantitative analyses based on given data in order to arrive at specific conclusions for an operational purpose.

Objective: **Problem-solving and critical thinking**	They are able to evaluate whether a certain question can be addressed by using the given data and possibly adjust the question and/or alter the data's structure with a view to applying data science methods to best serve the purpose at hand.
Objective: **Method skills**	They are familiar with a range of methods used in customer analytics.
Objective: **Communication skills**	They are able to visualize data and the results of their analyses comprehensibly and explain them plausibly.
Objective: **Interpersonal skills**	They are able to work with others independently to complete a project based on what they have learned.
Objective: **Personal skills**	They are aware of their limitations and know when they have reached a dead end, and they are able to use strategies to discover new approaches (contacts with experts, internet forums, creativity techniques, etc.).

Contents	
Topic 1: **Principles**	Understand the relevance of data science for managing customer experiences and customer relationships.
Topic 2: **Overview**	Overview of the role of data in the field of customer analytics: CRM data, customer data, transaction data, customer touchpoint data, social media data, web analytics data
Topic 3: **Analysis framework**	Approaches to customer analytics issues, basic analysis framework with drivers as independent variables and customer behavior as dependent variable
Topic 4: **Use cases**	Use cases involving customer analytics: (1) Customer experience management: Customer journey, (2) customer relationship management: Customer acquisition, customer loyalty (e.g. churn prognosis), customer development (e.g. cross-selling potential analysis, next-product-to-buy analyses).
Topic 5: **Specific uses**	Use of customer analytics in a specific use case (case work in groups) Alternative 1: Prognolite Alternative 2: Porsche
Topic 6: **Presentation**	Presentation of group projects.

Teaching and learning		
Coursework:	**Hours**	**Hours (%)**
Contact hours	30 hrs	33 %
Coaching	30 hrs	33%

Self-study	30 hrs	33%
Other		
Total	**90 hrs**	**100.0%**

Details on teaching and learning methods:

Teaching and learning methods: **Classroom**	Discussion-based lessons with current examples and applications
Teaching and learning methods: **Coaching**	(1) Coaching lessons with lecturers / practice partners (2) Presentation of the group work
Teaching and learning methods: **Self-study**	Familiarization with the methodology
Teaching and learning methods: **Other**	Working together as a group on a case, possibly with external partners from an applied field.

Assessments

(Adaptions are possible at any time.)

Assessments	**Assessment 1**	**Assessment 2**
Type of assessment	Presentation of the group work	
Evaluation type	Grades	
Scope	30 minutes, approx. 15 slides	
Dates	During the semester - according to the lecturer's information	
Weighting (if two assessments)	100%	
Aids/materials	None	

Notes on the assessments:

Language	German or English (free of choice)
Certificates	None
Attendance	Yes.

Teaching materials	
Literature	**Learning resources**
Lecture notes	Artun, O./Levin, D. (2015): Predictive Marketing: Easy Ways Every Marketer Can Use Customer Analytics and Big Data Glass, R./Callahan, S. (2015): The Big Data-Driven Business: How to Use Big Data to Win Customers, Beat Competitors, and Boost Profits Isson, P. (2018): Unstructured Data Analytics: How to Improve Customer Acquisition, Customer Retention, and Fraud Detection and Prevention Verhoef, P./Kooge, E./Walk, N. (2016): Creating Value with Big Data Analytics
Online resources	Various online resources on software use
Software	R, Phyton
Other resources	None

Data Analytics for Energy Systems and IoT

Module description	
Module code	W.MSCIDS_DE_DAE01.19
Module name	Data Analytics for Energy Systems and IoT
Most recent change	March 2021
Module concept	In the near future, energy systems will have to cope with numerous challenges (e.g. grid stabilization against power peaks of solar energy and electromobility, increasing grid maintenance costs, etc.). In addition, more and more data on consumer and user behavior is becoming available. This module focuses on sample applications that make it possible to develop new business models to ensure a reliable, cost-effective and environmentally friendly energy supply in the future.
Module type	Core Elective Module – Domain Experience
Form	Regular Course (weekly)
ECTS credits	3 ECTS Credits
Teaching language	English
Head	Philipp Schütz
Adjunct lecturers	Braulio Barahona, Andreas Melillo, Patrick Meyer

Module positioning	
Prerequisites	none
Recommended semester	none
Remarks	none

Module objectives	
Overall objective	Students analyze different panel and time series data of energy systems and IoT devices. For this purpose, they will develop models for classifying, monitoring and predicting the behavior of such systems at a given time.
Objective: **Professional skills**	Students - understand the main terms used in the context of energy systems and IoT technologies and are aware of the current problems. - understand different methods for modeling target values based on metadata and panel data, anomaly/state detection, and for modeling of time-dependent signals.

	- are able to compare different methods with regard to their suitability for solving an existing problem.
Objective: **Problem-solving and critical thinking**	Students are able to identify appropriate methods for solving a new analytical problem and to apply them and evaluate the results.
Objective: **Method skills**	Students are able to apply the presented methods to new data and interpret the results of the statistical package they used.
Objective: **Communication skills**	None
Objective: **Interpersonal skills**	Students are able to jointly identify and apply different methods to solve a problem and evaluate the results of their fellow students.
Objective: **Personal skills**	Students - are able to evaluate the results of externally analyzed data in terms of their plausibility and choice of methods. - are able to independently research additional forecasting methods for a given task and learn to use them of their own accord.

Contents	
Topic 1: **The principles of energy systems and use in Switzerland**	Energy requirements of Switzerland Overview of supply infrastructure and grids Structure of the national electricity grid Challenges of load balancing
Topic 2: **Collecting energy system data**	Different data sources and monitoring procedures Case example on collecting online data
Topic 3: **Remote diagnosis of bulk consumers / smart maintenance**	Monitoring the condition of heating systems by using heat pumps as an example Anomaly detection for bulk consumers
Topic 4: **Estimating residential energy demand**	Linear regression models for panel data Sensitivity analysis for system and environmental properties Modeling of various consumer types
Topic 5: **Load forecasting**	Time series models (autoregression, moving average, ARMA, ARIMA) (deep) neuronal network models to predict the consumption time series
Topic 6: **Internet of things**	Data acquisition with IoT devices Analysis of IoT data in practice

Teaching and learning		
Coursework:	**Hours**	**Hours (%)**
Contact hours	30 hrs	33.3%
Coaching	30 hrs	33.3%
Self-study	30 hrs	33.3%
Other		
Total	**90 hrs**	**100.0%**

Details on teaching and learning methods:

Teaching and learning methods: **Classroom**	Discussion-based lessons
Teaching and learning methods: **Coaching**	Exercises to further explore and apply the theory by means of problem-based learning
Teaching and learning methods: **Self-study**	Exercises to further explore and apply the theory by means of an own case study
Teaching and learning methods: **Other**	None

Assessments Adaptions are possible at any time.)		
Assessments	**Assessment 1**	**Assessment 2**
Type of assessment	Presentation of case studies (group work)	Written Examination
Evaluation type	Grades	Grades
Scope	10-min. presentation	60 minutes
Dates	During the semester - according to the lecturer's information	During the official examination period
Weighting (if two assessments)	30%	70%
Aids/materials	None	None

Notes on the assessments:

Language	German or English (free of choice)
Certificates	None

Attendance	None

Teaching materials	
Literature	None
Lecture notes	None
Online resources	None
Software	R with RStudio Python with Numpy, Scikit, Keras, statmodels and others
Other resources	None

Data Collection, Integration and Preprocessing

Module description	
Module code	W.MSCIDS_CIP02.18
Module name	Data Collection, Integration and Preprocessing
Most recent change	September 2021
Module concept	Quality and integrity of data are crucially important for specific contexts of data science. In this module, students learn how to collect data from different sources and to consolidate it for analytical purposes. The module covers learning to use specific Python components, applying the theories on data preparation processes, and managing a workflow.
Module type	Required module
Form	4 lessons every 2 weeks
ECTS credits	3 ECTS Credits
Teaching language	German / English
Head	Erwin Mathis (german)
Adjunct lecturers	Ramón Christen (english)

Module positioning	
Admission requirements	- Python for Data Scientists (W.MSCIDS_PDS01.18) - Computer Science Concepts for Data Scientists (W.MSCIDS_CSC01.18)
Recommended semester	2nd semester
Remarks	This module is designed to help students work with data structures and databases in connection with the Python programming language. **Recommendation of associated module:** NoSQL Lab with Python & MongoDB further develops students' knowledge of CIP.

Module objectives	
Overall objective	Students can collect structured and unstructured data from different sources, integrate such data as needed and complete the pre-processing tasks (e.g. extraction, transformation, enrichment, deduplication, etc.) appropriately.
Objective: **Professional skills**	Based on the preparatory "Python for Data Scientists" and "Computer Science Concepts for Data Scientists" modules, students will design and

	complete the basic *connect, collect, transform, enrich* and *publish* tasks (ETL) of a data engineer with the help of Python and current software.
Objective: **Problem-solving and critical thinking**	Students are able to determine the best way to prepare structured and unstructured data. They are able to explain why certain software tools are best suited for extracting, transforming, enriching, etc. data. Furthermore, they are able to use these tools when working on examples in an applied field. Students are able to process given data with current tools and suitable programming languages.
Objective: **Method skills**	Students are able to collect large data volumes themselves, prepare them properly, interpret the results correctly and present them adequately.
Objective: **Communication skills**	No explicit ones.
Objective: **Interpersonal skills**	Students are able to work with others to complete Assessments 2, whereby they will learn to address possible differences of opinion objectively.
Objective: **Personal skills**	No explicit ones.

Contents	
Topic 1: **Using Python to manipulate and prepare data structures**	- Introduction to data analysis with Pandas - Series, DataFrame, Index objects and other Pandas basics - Loading and saving data - Data cleansing and transformation - Data preparation: Linking, combining and reshaping
Topic 2: **Basics of data acquisition**	Providing basic content in preparation for the subsequent project - Introduction to ETL - Crawler for HTML sites: Introduction to and practice with the Beautiful Soup module
Topic 3: **Implementation of an ETL process**	Learn how to connect and use a Database to work on a ETL workflow as part of a project. Students are able to present the results as part of the "CIP Group Project"

Teaching and learning		
Coursework:	**Hours**	**Hours (%)**
Classroom or Online	30 hrs	33.3%
Coaching	0 hrs	0%
Self-study	30 hrs	33.3%

Other	30 hrs	33.3%
Total	**90 hrs**	**100.0%**

Details on teaching and learning:

Teaching and learning: **Classroom or online**	The contents of Topics 1 and 2 are shown as examples in the lectures. The self-study component involves exercises with which students can deepen their understanding of the topics. In special situations (e.g. Corona) the teaching style will be adapted.
Teaching and learning: **Coaching**	
Teaching and learning: **Self-study**	Exercises on Topics 1, 2 and 3 Students learn the content of Topic 3 (e.g. connect to a Database) independently. A Database is also used in the context of the project.
Teaching and learning: **Other**	Project work: Students apply what they have learned by working on a project in groups. Students apply the content of Topics 1 to 3 while working on a project.

Assessments

(Adaptions are possible at any time.)

Assessments:	**Assessment 1**	**Assessment 2**
Type of assessment	"CIP Group Project" Contains an - individually assessed part by each student and - a group part	
Evaluation type	Grade	
Scope	Individually: (details in "Deliverables"-File) - Well commented, executable code in a part of the project - individual video (5 min +/- 1 min) Group: (details in "Deliverables"-File) - overall project document (10-15 pages) - group video (7 min +/- 1 min)	
Date	During the semester - according to the lecturer's information	
Weighting	individually 70% / group 30%	
Aids/materials	Software Tools, VM	

Additional notes on the assessments:

Language	Your individual work (code documentation) and the group project documentation are written in German or English.
Certificates	None
Attendance	Topics 1, 2: Not mandatory (but highly recommended because of the group work) Topic 3: Mandatory (because of group work)

Teaching materials	
Literature	Python for Data Analysis, Wes McKinney, O'Reilly, 2nd edition, 2019
Script	None Various exercises
Online resources	Python Bootcamp: https://www.udemy.com/course/the-complete-python-masterclass
Software	Python PyCharm various Python frameworks
Other resources	Communicated during the classes.

Data Ideation

Module description	
Module code	W.MSCIDS_DI01.18
Module name	Data Ideation
Most recent change	July 2020
Module concept	The main module theme focuses on how data can be used to improve problem solving. It examines the key question of how to design a creative process in a given case with a view to bringing about a specific result for customers, clients and other stakeholders. Models and approaches include: Design thinking, agile project management, human-centered design, hybrid models, among others. The module familiarizes students with these approaches and provides them with direct experience in using the associated methods and tools.
Module type	General Core Elective Module
Form	Block Seminar on site (autumn semester: Feb. / spring semester: Aug. or Sept.)
ECTS credits	3 ECTS Credits
Teaching language	English
Head	Michael Lewrick
Adjunct lecturers	Esther Cahn

Module positioning	
Admission requirements	None
Recommended semester	1st semester
Remarks	The module examines a hybrid model for exploring data-driven innovations and iteratively develops a solution to a problem.

Module objectives	
Overall objective	Students use current concepts and tools for customized creativity throughout the design cycle – from the problem statement to a possible solution in data science.

Objective: **Professional skills**	The module relies on process models and tools from the field of big data/analytics as well as on process models and methods found in human-centered design (HCD). These form the basis for applying a hybrid approach that both methods share.
Objective: **Problem-solving and critical thinking**	Definition of problems for which data provides better solutions. Evaluation of methods in relation to when they are applied and their relevance in the design process.
Objective: **Method skills**	Working with effective methods throughout the design process as well as analyzing, visualizing and interpreting data, among other things.
Objective: **Communication skills**	Presenting the results and transforming data into experiential and physical interactions.
Objective: **Interpersonal skills**	Work in teams Exchange ideas with members of the class.
Objective: **Personal skills**	Responding to feedback from class members Reflecting on success and failure in the design process

Contents	
Topic 1: **Human-Centered Design**	Students complete an exercise to understand the principles of design thinking.
Topic 2: **Big Data /Analytics**	Students complete an exercise to understand the principles of data analysis. For example, they are able to use Tableau for visualizing data.
Topic 3: **Hybrid model**	A dry-run for using a hybrid approach, which later serves as basis for defining a problem. Application of all phases of the hybrid model.
Topic 4: **Communicating the results**	Preparing the results and communicating them to a specific audience.
Topic 5: **Independent work**	Managing a project independently and assuming responsibility for its quality (from defining the problem to finalizing the solution).
Topic 6: **Reflection**	Analyze the problem and procedure; exchange ideas retrospectively. Develop recommendations and identify the successful things learned from the module.

Teaching and learning		
Coursework:	**Hours**	**Hours (%)**
Contact hours	40 hrs	43.3%

Coaching	20 hrs	23.3%
Self-study	30 hrs	33.3%
Other		
Total	**90 hrs**	**100.0%**

Details on teaching and learning methods:

Teaching and learning methods: **Classroom**	Discussion-based lessons with current examples / introduction to group work / coaching in learning in groups
Teaching and learning methods: **Coaching**	Group projects to further explore and apply the theory by means of problem-based learning
Teaching and learning methods: **Self-study**	Visualize the applications and reflect on digital channels / exchange ideas in the group
Teaching and learning methods: **Other**	None

Assessments

(Adaptions are possible at any time.)

Assessments	**Assessment 1**	**Assessment 2**
Type of assessment	Present the status of the project, including strategy to be successful in the end.	Final presentation
Evaluation type	Grades	Grades
Scope	15 min. and 5 min. Q&A	30-min. presentation
Dates	During the block seminar - according to the lecturer's information	During the block seminar - according to the lecturer's information
Weighting (if two assessments)	40%	60%
Aids/materials	Projector	Open Book

Notes on the assessments:

Language	German or English (free of choice)
Certificates	None
Attendance	Five mandatory dates (block event)

Teaching materials	
Literature	German: Lewrick et. al (2018), Das Design Thinking Playbook, 2nd edition, Vahlen Munich. English: Lewrick et. al (2018), The Design Thinking Playbook, Wiley
Lecture notes	None
Online resources	Open Data Switzerland (https://opendata.ch/) Open Data Singapore, similar
Software	Tableau Download under: https://www.tableau.com/de-de
Other resources	Post-its

Data Quality

Module description	
Module code	W.MSCIDS_DQU02.21
Module name	Data Quality
Most recent change	June 2022
Module concept	The module provides students with insights and applied knowledge of the theoretical principles and application related to data quality in the context of data science and "Big Data". Students are able to recognize the importance of data quality as it relates to data preparation and to projects in the context of data science. In addition, they will have an overview of how instruments of data quality are conceptualized and of their possibilities and limitations. They will also be able to select and apply basic methods of the concepts and application of data quality in line with the nature of a particular problem. Finally, students are able to apply and evaluate the selected software, tools and techniques.
Module type	Required Module
Form	Regular Course (weekly)
ECTS credits	3 ECTS Credits
Teaching language	English
Head	Jürg Schwarz
Adjunct lecturers	None

Module positioning	
Admission requirements	Module "Design of Data Experiments" (W.MSCIDS_DDE01)
Recommended semester	2nd semester
Remarks	None

Module objectives	
Overall objective	Students are able to: - recognize the importance of data quality in the context of academic and applied research. - gain an overview of the topic of data quality and understand the features, as well as the limitations, that it offers. - select and apply the basic methods of data quality and tailor them to a particular problem. - apply and evaluate the selected software, tools and techniques.

	Students are thus able to adapt the methods of data quality to specific tasks from the field of applied data science.
Objective: **Professional skills**	Students are able to apply concepts and techniques of data quality to their own quantitative research projects.
Objective: **Problem-solving and critical thinking**	Students have an accurate sense of the possibilities and limitations of concepts and techniques of data quality and are able to select methods appropriate for typical problems and apply them in a solution-oriented manner.
Objective: **Method skills**	Students understand the methods of data quality at the desired level.
Objective: **Communication skills**	Students are able to correctly apply the specific language of concepts and techniques of data quality in reports, etc.
Objective: **Interpersonal skills**	Students are able to reflect on their skills concepts and techniques of data quality in the context of communication and interaction. Students are able to vary the form and content of their communication based on the situation with team members, customers, etc.
Objective: **Personal skills**	Students reflect on their skills when using concepts and techniques of data quality.

Contents	
Topic 1: **Introduction to data quality principles**	General introduction to data quality principles - Introductory examples - Exploring the principles of data quality
Topic 2: **Basic properties of data quality**	Introduction to the basic properties of data quality - Exploring the causes of data quality - Assessing data quality
Topic 3: **Data quality dimensions**	Data quality understood as a multi-dimensional concept where dimensions represent the views, criteria, and measurement attributes for data quality problems that can be assessed, interpreted, and possibly improved individually.
Topic 4: **Detecting data quality problems / Improvement of data quality**	Detecting quality problems (in research data): Procedures / Processes / Checklists / Data Quality Assessment Improvement of data quality: Techniques / Procedures / Algorithms
Topic 5: **Application of machine learning methods / Model-driven development**	Application of machine learning methods for e.g. missing data (imputation), outlier detection, identification of duplicates, … Model-driven development of data quality that allows abstracting from the underlying database technology
Topic 6: **Special topics**	Data quality in the context of … - large data quantities ("Big Data") - social media

Teaching and learning

Coursework:	**Hours**	**Hours (%)**
Contact hours	30 hrs	33.3%
Coaching	30 hrs	33.3%
Self-study	30 hrs	33.3%
Other		
Total	**90 hrs**	**100.0%**

Details on teaching and learning methods:

Teaching and learning methods: **Classroom**	Form: Presentation of lecture notes The content of the lecture notes is question-developing using examples. The lecture notes are stored electronically.
Teaching and learning methods: **Coaching in Tutorials**	Form: Tutorial Students solve applied problems and Students work through applied problems and questions in Exercises. The students are accompanied by the lecturers and assistants coaching the students. Students have to submit their work usually within a week. Suggested solutions are given for the exercises, which are to be comprehended by the students. Of the 10 exercises, 5 must be graded "Pass" in order for you to be admitted to the final exam.
Teaching and learning methods: **Self-study**	Independent self-study
Teaching and learning methods: **Other**	None

Assessments (Adaptions are possible at any time.)	
Type of assessment	Written examination
Evaluation type	Grades
Scope	90 minutes (60 min. exam, 30 min. preparation)
Dates	During the official examination period
Weighting (if two assessments)	100%
Aids/materials	Summary
Duration of final module examination	The exam period specified in the notification exceeds 90 minutes because it includes time for the preparatory work and submission.

Notes on the assessments:

Language	German or English (free of choice)
Certificates	None
Attendance	80% of the classes.

Teaching materials	
Literature	There are no mandatory materials. A list of sources for further reading will be provided at the beginning of the semester.
Lecture notes	None
Online resources	None
Software	R and RStudio software Instructions for installing R and RStudio are provided in the module "Classical and Bayesian Statistics".
Other resources	None

Data Science in Health Care

Module description	
Module code	W.MSCIDS_DE_ HEA01.18
Module name (English)	Data Science in Health Care
Most recent change	November 2022
Module concept	**Why health care?** There are both economic and non-economic reasons why we should all be interested in health care. From an economic perspective, Switzerland spent almost CHF 10,000 per person and year on health care in 2020 [1]. This corresponds to 12% of median household income (~ CHF 80,000 [2]). In addition, costs per person have grown year by year since 1996 (the year of the introduction of mandatory health insurance), 2.5% on average each year [1]. In an international comparison, Switzerland ranks second in the OECD's list of per capita health expenditures [3]. In view of these figures, it is not surprising that there is a lot of pressure to improve health care systems worldwide to keep them affordable. From a non-economic perspective, we have important health care issues to solve such as antibiotic resistances, chronic diseases, or adverse drug reactions due to inappropriate medication. For example, over 50% of all adults suffer from at least one chronic disease, and over 20% of them suffer from at least two [4]. **Why data science in health care?** Data science can play a decisive role in improving both the efficiency and quality of health care systems. In particular, data science can play a decisive role in fighting diseases such as cancer, improving digitization of services (e.g. "digital doctors"), developing effective prevention policies, and even in improving fraud detection. Therefore, there are many reasons why you should be excited to become a data scientist in health care! By working as a data scientist in health care, you can have a huge impact on people's lives and on the system's efficiency. **Why should you book this course?** This course allows you to take a first step into the fascinating domain of data science in health care. In this introductory module, you will learn more about the importance of data science in health care. Most importantly, you will work with real data from the sector, and you will apply the methods and knowledge acquired during your studies to extract knowledge from health care data. You will spend most of the time during this course working on your main project (which you choose yourself and you can even bring your own data if you wish). During the entire course you will be supported by an expert from the field. References: [1] BFS - Ausgaben für das Gesundheitswesen https://www.bfs.admin.ch/bfs/de/home/statistiken/querschnittsthemen/wohlfahrtsmessung/alle-indikatoren/gesellschaft/gesundheitsausgaben.html (accessed Nov 26, 2022) [2] BFS - Schweizerische Lohnstrukturerhebung (LSE) 2020 https://www.bfs.admin.ch/asset/de/21224887 (accessed Nov 26, 2022)

	[3] OECD. 2019. Health Spending. Available at https://data.oecd.org/healthres/health-spending.htm (accessed June 6, 2021) [4] Boersma, Peter. "Prevalence of Multiple Chronic Conditions Among US Adults, 2018." *Preventing Chronic Disease*17 (2020). https://doi.org/10.5888/pcd17.200130.
Module type	Core Elective Module - Domain Experience
Form	Regular Course (weekly)
ECTS credits	3 ECTS Credits
Teaching language	English
Head	Philip Hochuli (https://www.linkedin.com/in/philip-hochuli/)
Adjunct lecturers	None

Module positioning	
Admission requirements	Classical and Bayesian Statistics (W.MSCIDS_SA01.18)
Recommended semester	2nd Semester
Remarks	none

Module objectives	
Overall objective	Students are familiar with important applications of data science in health care. They are able to address analytical questions from the field by means of data and corresponding methods.
Objective: **Professional skills**	- Understand major trends in data science in health care - Be familiar with different sources of data from health care - Be able to prepare a data set for analysis - Be able to select and apply analytical methods for extracting information from data
Objective: **Problem-solving and critical thinking**	Students should be able to break down an analytical question into manageable parts and analyze them iteratively to answer the original, more complex question. They should also be able to identify the strengths and weaknesses of their own work.
Objective: **Method skills**	- Be able to prepare a data set for analysis - Be able to ask the right questions to the data in order to achieve your goals - Be able to select and apply appropriate analytical methods for extracting information from data
Objective: **Communication skills**	Students should be able to present their work to an attentive audience. They should be able to communicate the purpose of their work, the approach, the main results of the analyses, and the conclusions.
Objective: **Interpersonal skills**	Students should be able to solve a complex data science question collaboratively as a group.

Contents	
Topic 1: **Data Science in Health Care**	- Role and importance of data science in health care - Economic, medical, social and ethical implications of these trends
Topic 2: **Working with Data**	- Understand what data can look like in its raw and semi-structured form. - Understand how to handle data errors, missing data points and implausible values. - Process and cleanse data independently by means of structured procedures and supported decisions - Document and justify the selected procedure - Understand that data preparation is a critical step in the data science pipeline and that careful preparation is the basis for meaningful analyses.
Topic 3: **Analytics**	Understand basic but critically important principles of data analysis
Topic 4: **Presentation**	- Summary and presentation of the results - Evaluate the implications and formulating recommendations

Teaching and learning		
Coursework:	**Hours**	**Hours (%)**
Contact hours	30 hrs	33.3%
Coaching	30 hrs	33.3%
Self-study	30 hrs	33.3%
Other		
Total	**90 hrs**	**100.0%**

Details on teaching and learning methods:

Teaching and learning methods: **Classroom**	Discussion-based lessons
Teaching and learning methods: **Coaching**	Exercises to further explore and apply the theory by means of an own case study
Teaching and learning methods: **Self-study**	Exercises to further explore and apply the theory by means of an own case study
Teaching and learning methods: **Other**	None

Assessments (Adaptions are possible at any time.)		
Assessments	**Assessment 1**	**Assessment 2**
Type of assessment	Preliminary study for your main project (in groups of 3 - 4). As in the case of your Master's Thesis, this module also requires you to submit a preliminary study for your data project. The study should describe (among other things) the objectives of your work and the planned procedures. Detailed requirements will be given during the lecture.	Data science project based on a data set from the health care sector. Grading will be based on a presentation of your project. Detailed requirements will be given during the lecture.
Evaluation type	Grades	Grades
Scope	Two A4 pages (excl. title page and declaration of originality)	10 minutes presentation + 5 minutes to answer questions
Dates	During the semester - according to the lecturer's information	During the mid-term - according to the lecturer's information
Weighting (if two assessments)	30%	70%
Aids/materials	None	None

Notes on the assessments:

Language	German or English (free of choice)
Certificates	None
Attendance	80%

Teaching materials	
Literature	Students will receive the lecture slides with the optional, supplementary literature suggestions for the module at the beginning of the semester.
Lecture notes	None
Online resources	None
Software	R, Python or another programming language for professional and reproducible work on projects.
Other resources	None

Data Science Interview Training

Module description	
Module code	W.MSCIDS_DIT04.21
Module name	Data Science Interview Training
Most recent change	July 2021
Module concept	The students receive an in-depth training into the technical and non-technical parts of the interview process for a data science position in industry. Through a detailed recreation of real-world interviews, the students will be exposed to and guided through the full process of a job application – from CV and Cover letter preparation to solving a technical challenge to presenting and discussing their solutions. Technical and non-technical experts will provide the students with guidance and feedback on how to improve their performance in each step of the job application process. The ultimate goal is to help students build up their confidence and thus maximize their performance in job interviews.
Module type	Core elective module
Form	Online Block Seminar (autumn semester: Feb. / spring semester: Aug. or Sept.)
ECTS credits	3 ECTS Credits
Teaching language	English
Head	Laurent Meyer
Adjunct lecturers	Pavlin Mavrodiev Nitin Kumar Badru Stanicki

Module positioning	
Admission requirements	None
Standard semester	3rd semester
Remarks	None

Module objectives	
Overall objective	Through a reenactment of the complete interview process for a data science position this module aims at improving students' performance in real-life interviews. Hands-on assignments and individual feedback from experts will help students familiarize themselves with the challenges and expectations of such interviews.

Contents	
Day 1: Morning: Workshop on CV and Cover Letter Preparation Afternoon: Preparing a job application (hands-on)	Workshop on preparing a CV and Cover Letter for a job advertisement. Real job advertisements will be used as running examples through the course. Contents of the workshop: - Practical advice on job search - leveraging online social networks, avoiding common pitfalls, etc. - Tailoring one's application to a job advertisement with a focus on the Swiss market – common best practices and strategies The workshop takes place before noon. After that students will receive example job advertisements to which they will have to prepare a formal application consisting of a CV and Cover Letter. The application is to be submitted by 09:00 on the next day.
Day 2: Working on a technical data challenge (hands-on)	Continuing from the previous day students will work on a technical data challenge, which often accompanies real data science job advertisements. The data challenge will contain a dataset and accompanying instructions on the tasks that need to be done. However, as the goal is to mimic real scenarios, the instructions will not provide a step-by-step recipe on how to solve the challenge. Often one optimal solution does not exist and the purpose is to rather evaluate the thinking process and approach of the candidate in combination with his or her technical skills. This will also be the focus here. Students will be able to choose from several data challenges of varying difficulty reflecting their own capabilities. The challenges can be solved either with R or Python, depending on preference. Data Challenges will have to be submitted by 09:00 on the next day.
Day 3: Morning: General feedback on CV and Cover Letter from Day 1 Afternoon: Further instructions on how to solve the data challenge Afternoon: Work continues on solving the data challenges (hands-on)	In the morning overall feedback will be provided to all students on the strengths and weaknesses of the submitted applications from Day 1. This is not an individual feedback session, rather the general patterns observed in the submissions will be discussed, so that the applications can be improved. The afternoon session will contain further instructions on solving the data challenge by highlighting common pitfalls to avoid and successful strategies to follow. Student will self-assess their own work and will have the chance to improve it. Final submissions by 09:00 on the next day.
Day 4: Individual feedback on CV and Cover Letter and individual technical interviews	Students will have 20 minutes one-to-one career coaching session consisting of discussions and feedback rounds regarding their submitted CV, Cover Letter and overall career development strategy. In addition the final phase of the job application – namely the technical interview – will be conducted. This consist of: - Presentation of the submitted Data Challenge and associated feedback (10 mins) - Reenactment of a technical interview with a data science expert (10 mins)

	- Coding challenge with a technical expert covering common coding tasks expected in interviews (10mins)
Day 5: Individual feedback on CV and Cover Letter and individual technical interviews	All remaining career coaching sessions and technical interviews will be completed. Students receive final feedback on all steps of the process.

Teaching and learning		
Coursework:	**Hours**	**Hours (%)**
Contact hours	25 hrs	27.8%
Coaching	20 hrs	22.2%
Self-study	45 hrs	50%
Other		
Total	**90 hrs**	**100.0%**

Assessments
(Adaptions are possible at any time.)

Assessments	**Assessment 1**	**Assessment 2**
Type of assessment	Job application documents	Data challenge
Evaluation type	Individual feedback	Individual feedback
Scope	CV, Cover Letter	Individual data challenge results Technical interview
Dates	During the block seminar - according to the lecturer's information	During the block seminar - according to the lecturer's information
Weighting (if two assessments)	50%	50%
Aids/materials	Open book	Open book

Data Strategy and Governance

Module description	
Module code	W.MSCIDS_GOV03.22
Module name	Data Strategy and Governance
Most recent change	July 2023
Module concept	Learning on the base of Data strategy and be able to degive a Cloud based data Governance concept that is finally implemented in Azure Cloud.
Module type	General Core Elective Module
Form	Block Seminar
ECTS credits	3 ECTS Credits
Teaching language	English
Head	Dimitrios Marinos
Adjunct lecturers	Andreas Brandenberger, Mike Zehnder

Module positioning	
Admission requirements	Database Management for Data Scientists (W.MSCIDS_DBM02.18) At least one of the following modules: • Data-Driven Business Models • Management of Digital Enterprise • Data Warehouse and Data Lake Systems • Modern Data Engineering • NoSQL Lab with Python & MongoDB
Recommended semester	3rd Semester
Remarks	Get knowledge and additional an additional accredidated certification that will support your further career development.

Module objectives	
Overall objective	To Learn how to define and executre a Data driven strategy with a clear IT-Governance objective. Students will understand the business and IT impackt of missing compliance, standards and also bad Data Governacne on a Cloud/IT solution.Finally the students will get an introduction in the Azure cloud and have the chance to work directly on the Azure portal while setting Data and Service policies for governance purposes.
Objective: **Professional skills**	Data Strategy and strategy frameworks IT Governance and Policies Azure Cloud introduction
Objective: **Problem-solving and critical thinking**	Solving the IT and Business continuity problem while protecting intellectual property. How to create safe organisations and also build a policy strategy hands on in the cloud.

Objective: **Method skills**	Going through Data model strategy concepts and what needs to be considered for a successful journey. Use Strategy frameworks to guide IT to deliver value. Develop hands on strategies and data policies to reflect the strategy.
Objective: **Communication skills**	Presenting the results of a Strategy and Governance assessment. Showing implemented policies on the Azure Tenant as a team and explain governance strategies.
Objective: **Interpersonal skills**	Working with a team on exercises and projects during the course.

Contents	
Topic 1: Motivation and history	Learning how to define and apply a Data strategy. How to get wisdom out of you organisation and use it as business advantage.
Topic 2: Core concepts and methods	Data maping Cloud Governance Data Ruirements engineering.
Topic 3: Advanced topics	Governance and policy development in a cloud environment
Topic 4: Application	Direct development in the Cloud and introduction to Azure

Teaching and learning		
Coursework:	**Hours**	**Hours (%)**
Contact hours	40	
Coaching	N/A	
Self-study	35	
Other	5	
Total	**80 hrs**	**100.0%**

Details on teaching and learning methods:

Teaching and learning methods: **Classroom**	A mix of Online and Physical presentation during the week. The first 3 days are physical and the last 2 online.
Teaching and learning methods: **Coaching**	1 hour per team for consultation during the modul in order to clarify specific questions.
Teaching and learning methods: **Self-study**	Self-Study, Hands on at the Azure Cloud and presentations. Going through the material for the SC-900 Certificaiton

Teaching and learning methods: **Other**	Presentation (theory) Case studies Hand-on exercises per team

Assessments (Adaptions are possible at any time.)		
Assessments	**Assessment 1**	**Assessment 2**
Type of performance record	SC-900 Certificate (within 60days)	
Evaluation type	Microsoft Certification of SC-900 within the next 60Days. It will be online from the Microsoft Portal.	
Scope	Get the **Microsoft Security, Compliance, and Identity Fundamentals** certification (link)	2 x tries paied from HSLU
Date	During the semester - according to the lecturer's information	
Weighting (if two assessments)	100%	
Aids/materials	Module topics and Microsoft certification material (additional info, link).	

Notes on the assessments:

Language	English (presentation can be done in German)
Certificates	SC-900 Certificate from Microsoft (online)
Attendance	100%

Teaching material	
Literature	Micorsoft Azure (website)
Lecture notes	https://docs.microsoft.com/en-us/azure/governance/
Online resources	https://azure.microsoft.com/en-us/
Software	Azure.com
Other resources	NA

Data Visualization and Narration

Module description	
Module code	W.MSCIDS_DVN03.18
Module name	Data Visualization and Narration
Most recent change	July 2020
Module concept	Our ability to perceive and understand information depends strongly on how it is visualized and communicated. The content of messages containing optical stimuli, clear statements and familiar narratives is easier to understand than abstract data by itself. The module provides an initial insight into the prerequisites for enabling others to process information. Furthermore, it examines the principles of how we communicate data, process information and interpret complex facts. Students will learn how people perceive and process information, and they will understand the underlying principles of user-friendly visual communication aimed at transferring knowledge and making decisions, among other things.
Module type	General Core Elective Module
Form	Regular Course
ECTS credits	3 ECTS Credits
Teaching language	English
Head	Axel Vogelsang
Adjunct lecturers	Samuel Frei, Robert Bossart, Tobias Matter

Module positioning	
Admission requirements	None
Recommended semester	3rd semester
Remarks	None

Module objectives	
Overall objective	Students understand the cognitive requirements that enable people to perceive and process visual information as well as the challenges this poses for visual communication. They understand the necessity of adopting a human-centered approach when communicating complex data and information, as well as the factors that make this easier.

	Students understand the purpose of visually preparing data and information, such as conveying knowledge or decision results, and they know the strategies and methods used for preparing visual content for the intended purpose. They are able to commission specialists (interface designers, graphic designers) in information transfer and visualization and to evaluate their work in the context of human-centered communication.
Objective: **Professional skills**	Understand data/information visualization as a specific form of communication that must be user-oriented. Be able to define user groups for specific visualizations and determine the associated requirements. Understand the various goals of visualization (e.g. decision support or knowledge transfer) Understand the strategies and options for arriving at solutions for particular applications. Be able to develop visualization concepts that optimally serve a given purpose and the needs of users.
Objective: **Problem-solving and critical thinking**	Become fully literate in evaluating the impact of visualizations.
Objective: **Method skills**	Evaluate the potential in raw data and information with regard to visualization. Define goals for using the data so that people in general and users in particular can benefit optimally when it is visualized. Be able to evaluate visualizations in terms of their user-friendliness and usefulness.
Objective: **Communication skills**	Be able to commission and support specialists (e.g. graphic or interface designers) for appropriate user-oriented visualization. Be able to mediate between specialists with different approaches and perspectives, such as graphic designers and programmers. Be able to communicate data and information in a user-centered manner within an organization or to customers.
Objective: **Interpersonal skills**	Be able to work with graphic and interface designers and to program visual data and information as needed.
Objective: **Personal skills**	Be able to self-reflect and evaluate criticism. Understand how a target group can benefit from a particular design concept. Be able to critically reflect on one's own position and role. Be able to defend one's own work during a discussion. Be able to evaluate stakeholders' requirements and integrate them into projects and processes. Assume responsibility for processes, projects and their results and effects.

Contents	
Topic 1: **Principles**	Human perception and information processing and the consequences for human-centered and user-oriented visualization.

Topic 2: **Visualization of data**	Visualization of statistical data – goals, strategies and outcomes
Topic 3: **Data as narrative**	Cause and effect – data as narrative

Teaching and learning

Coursework:	**Hours**	**Hours (%)**
Contact hours	24 hrs	26.7%
Coaching	34 hrs	37.8%
Self-study	32 hrs	35.5%
Other		
Total	**90 hrs**	**100.0%**

Details on teaching and learning methods:

Teaching and learning methods: **Classroom**	None
Teaching and learning methods: **Coaching**	None
Teaching and learning methods: **Self-study**	None
Teaching and learning methods: **Other**	None

Assessments

(Adaptions are possible at any time.)

Assessments	**Assessment 1**	**Assessment 2**
Type of assessment	Working on a case study in the form of a design brief involving a visualization. This should be based on data that ideally comes from the students' own professional life, otherwise from the lecturer. Including a final report.	None
Evaluation type	Grades	None

Scope	Final report, 4-5 pages including illustrations	None
Dates	During the semester - according to the lecturer's information	None
Weighting (if two assessments)	100 %	None
Aids/materials	None	None

Notes on the assessments:

Language	German or English (free of choice)
Certificates	None
Attendance	80%

Teaching materials

Literature

Börner, K. & Polley D.E. (2014). Visual Insights – A Practical Guide to Making Sense of Data. London: The MIT Press.

Felton, N. (2016). Photoviz – Visualizing Information Through Photography. Berlin: Gestalten

McCandless, D. (2014). Knowledge is Beautiful (1st ed.). London: Harper Collins Publ. UK.

Heller, S. & Landers, R. (2014). Raw Data – Infographic Designers' Sketchbook. London: Thames & Hudson Ltd.

Klanten, R. & Ehmann, S. & Schulze, F. (2011). Visual Storytelling. Berlin: Gestalten

Munzner, T. (2014). Visualization Analysis and Design: Principles, Techniques, and Practice (Har/Psc). Boca Raton: Ak Peters Visualization Series.

Rendgen, S. (2018). Information Graphics (reprint). Cologne: TASCHEN.

Rogers, S. (2013). Facts are Scared. London: Guardian Books

Segaran, T., & Hammerbacher, J. (2009). Beautiful data : [the stories behind elegant data solutions]. Sebastopol, CA ; Farnham: O'Reilly.

Steele, J. & Iliinsky, N. (2010). Beautiful Visualization – Looking at Data Through the Eyes of Experts. Sebastopol: O'Reilly

Tufte, E. R. (1997). Visual explanations : images and quantities, evidence and narrative. Cheshire, Conn.: Graphics Press.

Tufte, E. R. (1984). The visual display of quantitative information. Cheshire, Conn: Graphics Press.

Ware, C.. (2012). Information Visualization: Perception for Design (3rd revised edition). Waltham, MA: Elsevier Ltd, Oxford.

Yau, N. (2013). Data Points – Visualisation tha means something. Indianapolis: Wiley & Sons

Lecture notes	None
Online resources	Information is beautiful: https://informationisbeautiful.net/ Visual Learning Center: http://blog.visme.co/
Software	None
Other resources	None

Data Warehouse and Data Lake Systems

Module description	
Module code	W.MSCIDS_DWL03.22
Module name	Data Warehouse and Data Lake Systems
Most recent change	June 2022
Module concept	A data warehouse (DW or DWH), also known as an enterprise data warehouse (EDW), describes a system for data integration, historization, analysis and reporting. It is a core component of the business intelligence process as a central repository to unite data from diverse sources to create analytical reports for workers within the company. The data stored in a data warehouse originates from operational systems such as production,marketing or sales. The data may pass through a functional data store. They may require data cleansing for additional operations to ensure data quality before used in the DW for reporting. The DWH concept emerged thirty years ago and is commomplace in the industry today and therefore an important concept for data scientists, as they might have to analyse DWH data in their future careers. A data lake (DL) is a further development of the DWH for the era of big data and especially large data volumes and a wide variety of structured, unstructured and semi-strucutred data formats. A DL is a repository of data stored in its natural/raw format (i.e., object blobs or files). A DL is a higlighly scalable store of heterogenous anlytical source. data, including raw copies of source system data, sensor data, and social data, as well as partially extracted data structures from raw data. The transformed data is used for tasks including: reporting, visualization, advanced analytics, and machine learning. A data lake can include structured data from relational databases (rows and columns), semi-structured data (CSV, logs, XML, JSON), unstructured data (emails, documents, PDFs) and binary data (images, audio, video). Whereas the data warehouse aligns different source schemata during the load process (schema integration before writing data into the DWH), the data lake leaves this task of semantic data integration mainly to the data scientist (schema integration after reading data form the DL). The Data Lake concept is becoming more and more important in practice in areas where the data volume exceeds the capabilities of SQL databases, where the data formats are too heterogneous for tabular storage, and where schema integration automation is too expensive. Therefore, it is important for data scientists to be able to analyse data from a data lake containing large quantities of heterogenous semi-raw source data.
Module type	Elective Module – Advanced Analytics and Engineering
Form	Regular Course (weekly)
ECTS credits	6 ECTS Credits
Teaching language	English
Heads	José Mancera, Luis Terán
Adjunct lecturers	Aigul Kaskina

Module positioning	
Admission requirements	Python for Data Science (W.MSCIDS_PDS01.18)

	Database Management for Data Scientists (W.MSCIDS_DBM02.18) Not selectable for students who have attended the previous modules DWL1 and/or DWL2
Recommended semester	3rd Semester
Remarks	

Module objectives	
Overall objective	Enable data scientists / engineers to integrate and analyze data in Data Warehouse and Data Lake systems. The course offers also hands-on sessions and presents implementations made in business practice.
Objective: **Professional skills**	• Explain the concepts of data warehouse and data lake systems with their characteristics and advantages. • Demonstrate how data warehouse and data lake can be observed in the context of case studies. • Data integration in data warehouse and data lake systems • Schema integration in data warehouse and data lake Systems • Data analysis and visualization using data warehouse and data lake systems
Objective: **Problem-solving and critical thinking**	Analize and resolve practical problems by using data warehouse or data lake systems.
Objective: **Method skills**	Research independently the information necessary for solving a self-chosen problem using a data warehouse or data lake system in decision-making.
Objective: **Communication skills**	Exchange feedback with peers
Objective: **Interpersonal skills**	Function effectively in the group
Objective: **Personal skills**	• Be able to work on practical topics on one's own and gauge and further develop the ability to learn independently • Submit results on time and further develop the ability to manage workloads and deadlines independently as needed

Contents	
Session 1:	Course details • Projects descriptions • Group creation • Course administration • AWS Intro Services Responsible lecturers: Luis Terán and Christian Volkmer from Amazon
Session 2:	Introduction to Data Lake Systems • Evolution of Data Warehouses w.r.t. Big Data • Motivation and Definition of Data Lake Systems • Business Requirements for the Data Lake

	• Data Analysis in the Data Lake • Schema on Read Resonsible lecturer: Luis Terán
Session 3:	Data Ingestion: • Data Pipelines (ETL, NLP, ML) • ETL Pipelines • Amazon Lamda Functions • REST APIs Responsible lecturer: José Mancera
Session 4:	Data Storage • Apache Airflow (Data Pipelines) • AWS Storage Services (S3) • Relational Database Services (RDS) Responsible lecturer: José Mancera
Session 5:	Flipped classroom: • Q&A session • Students work on their projects Responsible lecturer: Aigul Kaskina / José Mancera
Session 6:	Flipped classroom: • Q&A session • Students work on their projects Responsible lecturer: Aigul Kaskina / José Mancera
Session 7:	Midterm: • Midterm presentations (all groups will present on this session) Responsible lecturer: Luis Terán
Session 8:	AWS services • AWS Modern Data architecture for analytics • Flipped clasroom Responsible lecturers: José Mancera and Christian Volkmer from Amazon
Session 9:	Data Transformation • Data Quality • Production Data Pipelines Responsible lecturer: José Mancera
Session 10:	Flipped classroom: • Q&A session Responsible lecturer: Aigul Kaskina / José Mancera
Session 11:	Data Warehouse Systems I: • Evolution of Decision Support Systems • The Data Warehouse Environment • The Data Warehouse and Design • Granularity in the Data Warehouse Responsible lecturer: Luis Terán

Session 12:	Data Warehouse Systems II + Data Visualization: • The Data Warehouse and Technology • External/Unstructured Data and the Data Warehouse • ERP and the Data Warehouse • Data Visualization Tools (Tableau) Responsible lecturer: Luis Terán
Session 13:	Flipped classroom: • Q&A session Responsible lecturer: Aigul Kaskina / Luis Terán
Session 14:	Flipped classroom: • Project final presentations (all groups will present on this session) Responsible lecturer: Luis Terán

Teaching and learning

Coursework:	**Hours**	**Hours (%)**
Contact hours	60 hrs	33.3%
Coaching	60 hrs	33.3%
Self-study	60 hrs	33.3%
Other	--	-
Total	**180 hrs**	**100.0%**

Details on teaching and learning methods:

Teaching and learning methods: **Classroom**	Introduction to the module's design and the semester Lectures on the various topics as an introduction Students present the status of their project and discuss them in groups
Teaching and learning methods: **Coaching**	Guided project work, feedback by teachers Periodic presentation of projects advance by groups during flip classrooms Final project presentation
Teaching and learning methods: **Self-study**	Individual project work The basic concepts of DW and DL are introduced theoretically and practically. Then, based on this, during the semester, the students will work on specific projects in the area of DW or DWL.

Assessments

(Adaptions are possible at any time.)

Assessments	**Assessment 1**	**Assessment 2**
Type of performance record	Project work	N/A
Evaluation type	Grades	N/A

Scope	Max. 30 pages (index, references, and appendix not included in page limit)	N/A
Date	Projects will be conducted during the semester and final reports will be submitted at the end of the semester	N/A
Weighting (if two assessments)	100%	N/A
Aids/materials	All legitimate aids are permitted	N/A

Notes on the assessments

Language	English
Certificates	n/a
Attendance	

Teaching material	
Literature	• Vaisman, Alejandro, and Esteban Zimányi. "Data warehouse systems." Data-Centric Systems and Applications (2014). • Inmon, William H. Building the data warehouse. John wiley & sons, 2005. • F. Nargesian, E. Zhu, R. J. Miller, K. Q. Pu, and P. C. Arocena, "Data lake management: challenges and opportunities," Proc. VLDB Endow., vol. 12, no. 12, pp. 1986–1989, Aug. 2019, doi: 10.14778/3352063.3352116. • Laurent, D. Laurent, and C. Madera, Data Lakes, 1. Edition. Wiley-ISTE, 2020. • Gorelik, The Enterprise Big Data Lake: Delivering on the Promise of Hadoop and Data Science in the Enterprise, Illustrated Edition. Sebastopol, California: O'Reilly UK Ltd., 2019.
Lecture notes	The material will be provided every week
Online resources	Great Resources on O'Reilly Online Learning
Software	• Apache AirFlow • Python • Docker (Optional) • Databases (SQL, PostgreSQL) • Tableau • Git
Infrastructure	• Amazon AWS Services • GitHub

Database Management for Data Scientists

Module description	
Module code	W.MSCIDS_DBM02.18
Module name	Database Management for Data Scientists
Most recent change	November 2022
Module concept	The field of data science continues to gain popularity as ever-increasing volumes of detailed and valuable data are being generated for analyses. These structured data collections are called databases. Database management systems (DBMS) simplify working with large data quantities by providing tools for structuring, storing, manipulating and retrieving data in packages. These can be linked to analytical tools for processing large data collections that exceed the capacity of the main memory. In this module, students gain comprehensive knowledge of how to use relational databases and SQL.
Module type	Required Module
Form	Regular Course (weekly)
ECTS credits	3 ECTS Credits
Teaching language	German / English
Head	Michael Kaufmann
Adjunct lecturers	Georg Lampart, Luis Teran

Module positioning	
Admission requirements	- Computer Science Concepts for Data Scientists (W.MSCIDS_CSC01.18) - Python for Data Scientists (W.MSCIDS_PDS01.18)
Recommended semester	2nd semester
Remarks	The module group fully ensures coordination between data integration and DBMS.

Module objectives	
Overall objective	Enable data scientists to use appropriate tools with which to manage (structure, manipulate, query, analyze) large data collections stored in a databases.
Objective: **Professional skills**	1. Plan a database application for decision support and value creation from data 2. Install and operate an SQL database server 3. Define a database structure in SQL based on a database model derived from data sources

	4. Load data into a database server efficiently, and transform the data according to the target structure 5. Perform a data analysis (descriptive statistics) with SQL Queries 6. Optimize the runtime of SQL Queries by analyzing the optimizer's execution plan using materialized views, indexes, and subsampling 7. Visualize the result of SQL queries in an interactive dashboard to support decisions
Objective: **Problem-solving and critical thinking**	- Solve a technical problem in the group - Define a project goal during the semester
Objective: **Method skills**	Research independently the information necessary for solving a self-chosen problem by integrating database systems and data analysis in decision making.
Objective: **Communication skills**	Exchange feedback with peers
Objective: **Interpersonal skills**	Work together effectively in the team
Objective: **Personal skills**	- Be able to work on topics on one's own and gauge and further develop the ability to learn independently - Submit results on time and further develop the ability to manage workloads and deadlines independently as needed

Contents	
Topic 1:	Database Management - The concept of DBMS - The advantage of using DBMS for big data - How to create value from big data - How to plan a database application for decision support - Installing and operating an SQL database server
Topic 2:	Database Modeling - The entity-relationship model - The relational model - Normal forms - SQL DDL (CREATE TABLE …)
Topic 3:	Database Integration - SQL DML (INSERT, UPDATE, DELETE) - Comparing ETL and ELT - Loading large volumes of data efficiently (LOAD) - Data Transformation with SQL (INSERT INTO … SELECT…)
Topic 4:	Database Analysis - SQL DQL (SELECT … FROM … WHERE) - Views (CREATE VIEW … AS SELECT …) - Joining Tables (JOIN … ON) - Aggregating data (COUNT, SUM, AVG, MIN, MAX) - Subqueries (WHERE … IN (SELECT …)) - Grouping statistics (GROUP BY) - Ordering results (ORDER BY)

	- Limiting results (LIMIT)
Topic 5:	Database Optimization - Analyzing the execution plan (EXPLAIN SELECT …) - Materialized Views (CREATE TABLE … AS SELECT …) - Indexes (CREATE INDEX …) - Subsampling (WHERE RAND() < 0.5)
Topic 6:	Database Visualization - Setting up and running a BI dashboard - Connecting the BI-Tool to the database server - Getting data to the dashboard using an SQL query - Configuring a visualization - Interpreting the result for decision support

Teaching and learning		
Coursework:	**Hours**	**Hours (%)**
Contact hours	30 hrs	33.3%
Coaching	30 hrs	33.3%
Self-study	30 hrs	33.3%
Other		
Total	**90 hrs**	**100.0%**

Details on teaching and learning methods:

Teaching and learning methods: **Classroom**	- Organizational questions - Summary of video lectures and book reading - Interaction in the format of the teaching conversation ("Lehrgespräch", Q&A) - Student presentations of exercises - Student presentations of project status - Feedback and advice - Questions and answers
Teaching and learning methods: **Coaching**	- Team exercises on all course contents (1 per session) - 1 Semester project over all sessions - Project report
Teaching and learning methods: **Self-study**	- Watching Video Lectures - Reading the Book "SQL & NoSQL Databases"
Teaching and learning methods: **Other**	- Optional team work (choice) or individual work on the semester-project ("Aufgabenstellendes Lehren")

Assessments (Adaptions are possible at any time.)		
Assessments	**Assessment 1**	**Assessment 2**
Type of assessment	Project work with a SQL DB	
Evaluation type	Grades	
Scope	Typically 15-25 Pages, however there is no formal limitation. The report must satisfy all 6 criteria communicated at the beginning of the course.	
Dates	Student presentations on project progress in every session during the semester according to the semester plan on ILIAS.	
Weighting (if two assessments)	100%	
Aids/materials	All legitimate aids are permitted.	

Notes on the assessments:

Language	German or English
Certificates	None
Attendance	No

Teaching materials	
Literature	Andreas Meier, Michael Kaufmann (2016). SQL- & NoSQL-Datenbanken. Springer On SpringerLink: https://link.springer.com/book/10.1007/978-3-662-47664-2
Lecture notes	- Slides of Video Lectures - Exercise sheets - SQL Workbook (step-by-step guide)
Online resources	Tutorial and SQL workbench www.sql-nosql.org
Software	- MySQL Server - MySQL Workbench - Metabase
Other resources	

Data-Driven Business Models

Module description	
Module code	W.MSCIDS_DDB01.018
Module name	Data-Driven Business Models
Most recent change	November 2022
Module concept	The world's most successful companies today are all looking to use and analyze data to add value to their products and services. In addition to global market leaders such as Amazon, Google and Facebook, small and medium-sized enterprises and individual companies are also increasingly focusing on the development of data-driven products and services. In all these business models, the economic value of data plays a crucial role. In addition, so-called ecosystems are increasingly being observed: in these, companies from a wide range of industries partner together to offer customers a seamless one-stop-shop experience. During this module, we will concentrate on developing a (data-driven) business model and explore questions such as: • What characterizes (data-driven) business models? • What are the main problems faced by today's players that a particular ecosystem or (data-driven) business model can solve? • What incentives need to be given to individual actors so that they participate in the ecosystem? • What are the potential hurdles and risks in implementing the business model?
Module type	General Core Elective Module
Form	Regular Course (weekly)
ECTS credits	3 ECTS Credits
Teaching language	English
Head	Florian Schreiber
Adjunct lecturers	KLARA Business AG

Module positioning	
Admission requirements	None
Recommended semester	2nd semester
Remarks	None

Module objectives	
Overall objective	Students analyze and develop their own data-based business model that can be implemented only by using modern data technologies and analytical methods.
Objective: **Professional skills**	Students develop their own view of the digital transformation as a new social and economic paradigm.
Objective: **Problem-solving and critical thinking**	Students are able to define the dimensions and elements of the relevant business models and develop them individually in a precise and plausible manner.
Objective: **Method skills**	Students are able to use suitable instruments to explain technological developments and analyze their influence on data-based business models. They are also able to develop and use a roadmap for a data-based business model.
Objective: **Communication skills**	Students are able to develop the technical, economic and customer-specific dimensions of data-based business models in companies. Moreover, they are able to pitch their business idea in front of hypothetical investors.
Objective: **Interpersonal skills**	Students are able to recognize some of the typical pitfalls encountered in data-based business models that generally affect collaboration involving multiple disciplines.
Objective: **Personal skills**	Students are able to identify the opportunities and risks inherent in data-based business models and reflect on them critically based on their individual values [connection to the advanced module "Ethical and Legal Issues of Big Data"].

Contents	
Topic 1: **Introduction**	1 Introduction 1.1 Importance and Relevance of Data 1.2 Central Aspects of the Digital Transformation 1.3 Online Business Models 1.4 Ecosystem of KLARA
Topic 2: **Business Model Innovation**	2 Business Model Innovation 2.1 Central Elements of a Business Model 2.2 Business Model Innovation Process
Topic 3: **Platform-based Business Models**	3 Platform-based Business Models 3.1 Actors and Definitions in the Platform Business 3.2 Modeling Platform-based Business Models
Topic 4: **Workshop/Coachings**	4 Workshop/Coachings 4.1 Workshop with practitioners (subject to availability) 4.2 Individual coachings with groups

Teaching and learning		
Coursework:	**Hours**	**Hours (%)**

Contact hours	30 hrs	33.3%
Coaching	30 hrs	33.3%
Self-study	30 hrs	33.3%
Other		
Total	**90 hrs**	**100.0%**

Details on teaching and learning methods:

Teaching and learning methods: **Classroom**	Discussion-based lessons with theoretical inputs
Teaching and learning methods: **Coaching**	Workshops and coachings to further explore and develop the student's business ideas by means of problem-based learning
Teaching and learning methods: **Self-study**	
Teaching and learning methods: **Other**	

Assessments

(Adaptions are possible at any time.)

Assessments	**Assessment 1**	**Assessment 2**
Type of assessment	Pitch Presentation (in groups)	
Evaluation type	Grades	
Scope	20 minutes	
Dates	During the semester - according to the lecturer's information	
Weighting (if two assessments)	100%	
Aids/materials	Closed book	

Notes on the assessments:

Language	German or English (free of choice)
Certificates	None
Attendance	80%

Teaching materials	
Literature	Christensen, C.M.; Raynor, M.E.; McDonald, R. (2015). What Is Disruptive Innovation? *Harvard Business Review.* Davenport, Tom (2017): What's Your Data Strategy. *Harvard Business Review*. Gassmann, O.; Frankenberger, K.; Csik, M. (2014). The Business Model Navigator: 55 Models That Will RevolutioniseYour Business. Kreutzer, Ralf T.; Neugebauer, Tim; Pattloch, Annette (2018): Digital Business Leadership. Digital Transformation, Business Model Innovation, Agile Organization, Change Management. Berlin, Heidelberg: Springer Berlin Heidelberg (Management for Professionals). Available at: http://dx.doi.org/10.1007/978-3-662-56548-3 Redman, T. C. (2018): 5 Concepts That Will Help Your Team Be More Data-Driven. *Harvard Business Review*. Swiss Re (2019). Digital Ecosystems: Extending the Boundaries of Value Creation in Insurance. *Swiss Re Institute Expertise Paper*. Swiss Re (2020). Data-Driven Insurance: Ready for the Next Frontiert? *Sigma*.
Lecture notes	see ILIAS
Online resources	None
Software	None
Other resources	None

Data-driven Supply Chain Management and Logistics

Module description	
Module code	W.MSCIDS_DE_LOG01.22
Module name	Data-Driven Supply Chain Management (SCM) and Logistics
Most recent change	June 2022
Module concept	In this module, students will learn about the role of information research and data science for global supply networks and logistics. They will recognize how the increase of real-time information flows from raw material supplier to the final consumer enables data analyses which support strategic and operational decision making within and across organisations. After an initial introduction to the topic of Supply Chain Management and Logistics, students will work on real-life data sets brought into the classroom by the two practitioner lecturers from Kühne + Nagel as well as Bossard. They will be given clearly defined problems, work with the companies' logistics and supply chain data and receive the support they need in conducting the analysis and presenting their proposed solutions.
Module type	Core Elective Module – Domain Experience
Form	Regular Course (weekly)
ECTS credits	3 ECTS Credits
Teaching language	English
Head	Uta Jüttner
Adjunct lecturers	Matthias Hodel, Urs Güttinger

Module positioning	
Admission requirements	Classical and Bayesian Statistics (W.MSCIDS_SA01.18) Python for Data Science (W.MSCIDS_PDS01.18)
Recommended semester	2nd Semester
Remarks	None

Module objectives	
Overall objective	Students generate managerial insight concerning the design of more sustainable, resilient and efficient supply chain and logistics processes by analysing small and large data sets.
Objective: **Professional skills**	They are able to carry out quantitative analyses of given data as a basis for improving the supply network design and processes.
Objective: **Problem-solving and critical thinking**	Students identify the required input parameters, assess the influence of the parameters and/or optimize the parameterization in order to solve supply chain process-related business issues.
Objective: **Method skills**	They are familiar with selected, use case- and hence problem-specific methods used in SCM and logistics.
Objective: **Communication skills**	They visualize the key insights from their data analyses and derive and synthesise the most important implications for decision making.
Objective: **Interpersonal skills**	They recognize and acknowledge the positive and/or negative stress that the work with practitioners on real business challenges may impose on group dynamics and integrate mitigating measures.

Contents	
Topic 1: Motivation and history	Students acknowledge that the way companies in supply chains go to market and the very way supply chains compete is being transformed through digitisation of information.
Topic 2: Core concepts and methods	▪ Introduction to supply chain management and logistics ▪ Supply network resilience ▪ Network modelling ▪ Smart logistics service design
Topic 3: Advanced topics	Data analysis methods to support the core topics above (supply network resilience, network modelling, smart logistics service design).
Topic 4: Application	Three use cases: Two real life from Kühne + Nagel and Bossard and one from a telecom industry

Teaching and learning		
Coursework:	**Hours**	**Hours (%)**
Contact hours	30	33 %
Coaching	20	22 %
Self-study	40	44 %
Other		
Total	**90 hrs**	**100.0%**

Details on teaching and learning methods:

Teaching and learning methods: **Classroom**	Discussion-based lessons with classic concepts as well as topical subjects and real company issues
Teaching and learning methods: **Coaching**	Coaching with University and Practitioner lecturers
Teaching and learning methods: **Self-study**	▪ Background reading concerning the domain and its characteristics as well as the core concepts covered in the classroom ▪ Background reading on the companies and use cases covered in the module
Teaching and learning methods: **Other**	

Assessments
(Adaptions are possible at any time.)

Assessments	**Assessment 1**	**Assessment 2**
Type of performance record	Presentation of group works	
Evaluation type	Grades	
Scope	15 – 20 minutes presentation plus 10 to 15 minutes discussion and Q&A	
Date	During the semester – according to the lecturer's information	
Weighting	100%	

(if two assessments)		
Aids/materials	-	

Notes on the assessments:

Language	English
Certificates	none
Attendance	80% attendance requirement

Teaching material	
Literature	A reader with articles (pre- and postreading to the classes) will be provided on Ilias
Lecture notes	Handouts and provided data sets
Online resources	-
Software	R, Python, Tableau
Other resources	-

Deep Learning

Module description	
Module code	W.MSCIDS_DPL03.22
Module name	Deep Learning
Most recent change	June 2022
Module concept	Computer Vision and Natural Language Processing have become ubiquitous in society, and there are numerous applications in fields such as image search, drones, self-driving vehicles, speech recognition, bots, machine translation and summarization of text. The underlying principles for many of these applications are neural networks ("deep learning") which have fundamentally changed the performance of computer vision systems and computational language technologies. Students are introduced to the fundamentals of neural networks. They learn how to implement, train, debug and optimize neural networks for various tasks in computer vision and language modeling.
Module type	Core Elective Module – Advanced Analytics and Big Data
Form	Regular Course (weekly)
ECTS credits	3 ECTS Credits
Teaching language	English
Head	Mirko Birbaumer
Adjunct lecturers	None

Module positioning	
Admission requirements	Applied Machine Learning and Predictive Modelling 1 (W.MSCIDS_MPM02.18) Applied Machine Learning and Predictive Modelling 2 (W.MSCIDS_MPM03.19) Not selectable for students who have attended Deep Learning Bootcamp (W.MSCIDS_DLB03.19).
Recommended semester	3rd Semester
Remarks	None

Module objectives	
Overall objective	Students are able to explain and compare a range of deep learning methods for solving problems related to computer vision and computational language technologies. They are able to explain the underlying algorithms and technologies of these methods, select suitable models for a given data set, and explain their choice. Furthermore, they have the necessary practical experience in solving exemplary problem tasks of varying complexity, are able to explain the possibilities and limitations of the methods used, and can apply them to new data sets. Students are able to deepen their understanding of the underlying

	technologies independently, follow developments in new research areas, and apply what they have learned.
Objective: **Professional skills**	Students are able to explain the theoretical principles of the most relevant deep learning methods and how they can be applied to image and text data sets. They are able to explain different validation methods and metrics in order to compare different models with respect to their performance, uncertainty and limitations.
Objective: **Problem-solving and critical thinking**	Students are able to independently assess whether a problem in computer vision or computational text technologies can be solved by means of a deep learning method, select suitable deep learning methods, and apply these methods to the data. Students are able to explain the specific requirements, conditions and limitations of the methods used. They are able to summarize the historical development up to the latest state of research of the discipline. Students are able to reflect and evaluate their own knowledge with respect to the state-of-the-art expertise of these technologies.
Objective: **Method skills**	Students are familiar with cutting-edge tools and can apply them accurately and efficiently to solve specific problems.
Objective: **Communication skills**	Students are able to present the analysis of image and text data correctly, coherently and vividly to expert and lay audiences.
Objective: **Interpersonal skills**	Critical and respectful discussions in groups.

Contents	
Topic 1: Motivation and history	*History of Neural Networks* *Classical Image Classification Methods* - Overview of data-driven image classification algorithms - K-nearest neighbor classifier implemented with NumPy - Validation of classification methods (training/validation/test split, cross-validation) - Linear classification algorithms (SVM) - Optimization (stochastic gradient descent) for various loss functions
Topic 2: Core concepts and methods	*Training and Optimizing Fully Connected Neural Networks* - Historical overview and neurobiological motivation of neural networks - Fully connected neural networks - Activation functions - Backpropagation - Dropout and Batch Normalization - Neural networks with Tensorflow and Keras *Convolutional Neural Networks (CNN)* - Convolutional layers and max pooling - CNN architectures (AlexNet, VGG, ResNet, etc.) - CNNs with Tensorflow and Keras - Transfer learning

	Recurrent Neural Networks (RNN) - Language Models and RNNs - Long short-term memory networks (LSTM) - Gated recurrent units (GRU)
Topic 3: Advanced topics	*Transformers* - Attention and self-attention - Pretrained Transformer Language Models *Graph Neural Networks (GNN)* - Node Classification - Link prediction - Graph classification and visualization
Topic 4: Application	- Image classification and visual explanation of deep learning models (Grad-CAM, Layer-wise Relevance Propagation) - Text classification and text generation - Image captioning - Social network analysis

Teaching and learning		
Coursework:	**Hours**	**Hours (%)**
Contact hours	28 hrs	31.1%
Coaching	4 hrs	4.5%
Self-study	58 hrs	64.4%
Other		
Total	**90 hrs**	**100.0%**

Details on teaching and learning methods:

Teaching and learning methods: **Classroom**	Short lectures on the theoretical concepts, followed by hands-on examples (prepared programming examples to be adapted to specific tasks) individually or in groups. Subsequent reflection through clicker tasks / quizzes, as well group as plenary discussions.
Teaching and learning methods: **Coaching**	Exercises for each topic.
Teaching and learning methods: **Self-study**	Extensive lecture notes with code examples.
Teaching and learning methods: **Other**	None

Assessments

(Adaptions are possible at any time.)

Assessments	Assessment 1	Assessment 2
Type of performance record	Written examination	
Evaluation type	Grade	
Scope	120min	
Date	During the official examination period	
Weighting (if two assessments)	100%	
Aids/materials	Open book, laptop.	

Notes on the assessments:

Language	English
Certificates	None
Attendance	None

Teaching material

Literature	Inidicated at the end of each chapter of the lecture notes. *Deep Learning with Python*, F. Chollet (2021, Manning)
Lecture notes	Lecture notes are provided.
Online resources	- Convolutional Neural Networks for Visual Recognition, http://cs231n.stanford.edu/ - Natural Language Processing with Deep Learning, https://web.stanford.edu/class/cs224n/
Software	Python, Keras and Tensorflow
Other resources	None

Design of Data Experiments

Module description	
Module code	W.MSCIDS_DDE01.18
Module name	Design of Data Experiments
Most recent change	June 2021
Module concept	The module provides students with insights and applied knowledge of the theoretical principles and application relating to the design of experiments (DoE) in the context of data science and big data. Students are able to recognize the importance of the design of experiments in the context of academic research. In addition, they will have an overview of how instruments of the design of experiments are conceived and of their possibilities and limitations. They will also be able to select and apply basic methods of the design of experiments in line with the nature of a particular problem. Finally, students are able to apply and evaluate the selected software, tools and techniques.
Module type	Required Module
Form	Regular Course (weekly)
ECTS credits	3 ECTS Credits
Teaching language	English
Head	Jürg Schwarz
Adjunct lecturers	None

Module positioning	
Admission requirements	None
Recommended semester	1st semester
Remarks	None

Module objectives	
Overall objective	Students are able to: - recognize the importance of the design of experiments in the context of academic research. - gain an overview the design of experiments and understand the possibilities it offers as well as its limitations. - select and apply the basic methods of the design of experiments and tailor them to a particular problem. - apply and evaluate the selected software, tools and techniques.

	Students are thus able to adapt the methods of the design of the experiments to specific tasks from the field of applied data science.
Objective: **Professional skills**	Students are able to apply the design of experiments to their own quantitative research projects.
Objective: **Problem-solving and critical thinking**	Students have an accurate sense of the possibilities and limitations of the design of experiments and are able to select methods appropriate for the problem and apply them in a solution-oriented manner.
Objective: **Method skills**	Students understand the methods of the design of experiments at the desired level. Students are able to conduct basic type of multi-factorial ANOVA using the software R.
Objective: **Communication skills**	Students are able to correctly apply the specific language of the design of experiments in reports, etc.
Objective: **Interpersonal skills**	Students are able to reflect on their skills in the design of experiments in the context of communication and interaction. Students are able to vary the form and content of their communication based on the situation with team members, customers, etc.
Objective: **Personal skills**	Students reflect on their skills when using the design of experiments.

Contents	
Topic 1: **Introduction to the design of experiments theory**	Introduction to the design of experiments (DoE) theory Exploring the research process and the properties of research designs Principles of the design of experiments
Topic 2: **Properties of experiments**	Introduction and study of the inferential statistical properties of experiments Population vs. sample Sampling methods Effect size / power analysis Statistical limits of experiments in the context of large data quantities
Topic 3: **Design of experiments**	Design of experiments (DoE) theory Construction experiment plans Variations of design of experiments I Variations of design of experiments II Connection between the design of experiments and analytical procedures
Topic 4: **Carrying out experiments**	Planning and carrying out experiments Using the software, tools and techniques Analyzing factorial designs based on ANOVA Examples
Topic 5: **Data structures and types**	Design of experiments depending on data structures and types Made data and found data Other
Topic 6: **Special cases**	Carrying out experiments in the context of … large data quantities social media

Teaching and learning		
Coursework:	**Hours**	**Hours (%)**
Contact hours	30 hrs	33.3%
Coaching	30 hrs	33.3%
Self-study	30 hrs	33.3%
Other		
Total	**90 hrs**	**100.0%**

Details on teaching and learning methods:

Teaching and learning methods: **Classroom**	Form: Presentation of lecture notes The content of the lecture notes is question-developing using examples. The lecture notes are stored electronically.
Teaching and learning methods: **Coaching in Tutorials**	Form: Tutorial Students solve applied problems and Students work through applied problems and questions in Exercises. The students are accompanied by the lecturers and assistants coaching the students. Students have to submit their work usually within a week. Suggested solutions are given for the exercises, which are to be comprehended by the students. Of the 10 exercises, 5 must be graded "Pass" in order for you to be admitted to the final exam.
Teaching and learning methods: **Self-study**	Independent self-study
Teaching and learning methods: **Other**	None

Assessments (Adaptions are possible at any time.)	
Type of assessment	Written examination
Evaluation type	Grades
Scope	90 minutes (60 min. exam, 30 min. preparation)
Dates	During the official examination period
Weighting (if two assessments)	100%
Aids/materials	Summary
Duration of final module examination	The exam period specified in the notification exceeds 90 minutes because it includes time for the preparatory work and submission.

Notes on the assessments:

Language	German or English (free of choice)
Certificates	None
Attendance	80% of the classes.

Teaching materials	
Literature	There are no mandatory materials. A list of sources for further reading will be provided at the beginning of the semester.
Lecture notes	None
Online resources	None
Software	R and RStudio software Instructions for installing R and RStudio are provided in the Statistical Analysis for Data Science module.
Other resources	None

Designing and Managing Data Science Projects

Module description	
Module code	W.MSCIDS_DMP01.22
Module name	Designing and Managing Data Science Projects
Most recent change	December 2022
Module concept	This module examines the transfer of business requirements to projects that enable data-driven decision making. At the same time, these projects make it possible to incorporate the new requirements that arise when businesses recognize the possibilities that data science offers. This module also focuses on the possibilities of integrating data science and data analytics into important decision-making processes. A detailed understanding of current decision making helps to identify the potential for managing projects more intelligently. The module looks at how people currently evaluate their options and examines the role of big data in operational and strategic business decisions. At the beginning of the module the spotlight is on a) communicating and establishing an iterative way of thinking in the sense of "testing, measuring, learning, improving" and on b) the right set-up, structure and management of data science projects in order to improve their chances of success. In particular, the module addresses the practical challenges in the earliest project phases (e.g. briefing, kick-off, initial requirements, pitching). The design of a project has a direct impact on how to manage and pitch it and on its success in general. The module examines the methods, corporate culture, preparatory work, decisions and agreements before a project is launched. The early project phases of planning and collaboration are crucial for efficient work and for managing the expectations on all sides. Later on the module focus shifts to the later project phases and on project work and management. The module also focuses on traditional and agile project methods and on their practical effects on stakeholders. Students learn how to manage data projects successfully by understanding the role of collaboration, intelligent project task management, stakeholder management, and stakeholder expectations. This includes learning from mistakes when discovering new business requirements and deciding on how to best integrate or ignore what has been learned. Once organizations have acquired the necessary technical skills, they must be able to manage their projects effectively and efficiently in order to succeed. Furthermore, data projects are never managed in isolation, and project managers must therefore know the business context when working with data and be able to anticipate the implications for their company's policies. The module focuses also on the role of communication and the planning process in data science projects as derived from the practical challenges that arise once a project has been launched (e.g. in the late process steps after the pitch). In these later project phases, project managers must come to terms with an existing approach and a defined project setting. To ensure the success of the project and deliver the envisioned

	results, it may be necessary to review project plans that have already been communicated.
Module type	General Core Elective Module
Form	Regular Course (weekly)
ECTS credits	3 ECTS Credits
Teaching language	English
Head	Michael Zehnder
Adjunct lecturers	Barbara Kummler

Module positioning	
Admission requirements	Not selectable for students who have already attended Managing Data Science Projects (W.MSCIDS_DDP02.18).
Recommended semester	2nd Semester
Remarks	None

Module objectives	
Overall objective	This module aims to develop students' ability to turn business requirements into successful projects, which in turn enable data-based decision-making processes. The projects will succeed because they are useful and suitable for the organization. It also enables students to successfully manage a data project by considering the known, new, obvious and implicit business requirements. This includes: Understanding the corporate culture, cooperating efficiently and making data-driven decisions. Sub-goals are: - Identify, understand and arrange business requirements for data-based decision-making processes. Define the corresponding requirements on the data and design projects accordingly so as to create tangible value from the data. - Understand the basic methods used in project management during the implementation and operational phases of projects. - Involve all relevant stakeholder groups to arrive at meaningful and valuable results from the data. - Gain insights into the specific challenges and obstacles that SMEs and conglomerates face and identify ways to overcome them.
Objective: **Professional skills**	Students - gain an overview of the typical and basic requirements for managing data science projects with a focus on classical and new project management methods. - understand specific examples of successful data science projects and of exemplary and challenging processes. Furthermore, they will develop useful concepts for these tasks under the guidance of the lecturers. - learn to learn from success and failure. - understand the current trends in project management methods (e.g. lateral leadership, agility, scrum etc.) and are able to discern the useful elements from these and apply them in a given situation.

Objective: **Problem-solving and critical thinking**	Students - are able to critically evaluate and apply existing project methodologies in the context of a case study. - are able to anticipate important challenges and critical situations in project design and planning. - are able to identify fundamental challenges and anticipate critical situations when working on data science projects.
Objective: **Method skills**	Students know the main methods and tools of project management and can apply them adequately in the early kick-off, briefing and tendering phases as well as in the operational phases of data science projects following a successful pitch. The methods for these phases focus on the basics of project management and scrum in the context of data science.
Objective: **Communication skills**	Students are able to communicate effectively with team members and move projects forward with their and the client's support and with help obtained from internet forums.
Objective: **Interpersonal skills**	When managing data science projects, students express their own needs, taking into account the importance and role of the social dimension. The classes serve as training opportunities for this purpose.
Objective: **Personal skills**	Students learn to recognize and diagnose critical events and emerging trends relating to projects by paying attention to the emotions and associations that are triggered by the involuntary anticipation of events. They will understand the role of self-reflection in successful project management.

Contents	
Topic 1: **Underlying principles of managing data projects**	Traditional project management (incl. waterfall and phase models) Agile, hybrid project management and new approaches like hcd and lean. Advantages and disadvantages of traditional vs. new project management approaches to data science projects Focus on all phases of project management: - Focus on the time before pitching a project to the customer (kick-off, briefing, planning, estimation, initial customer communication) - - Focus on the time after pitching a project, i.e. on the implementation and ongoing communication and cooperation with customers up to the successful completion of the project.
Topic 2: **Project management expertise**	Be able to apply project management expertise and existing experience in realistic situations: - Understand the communication aspects of stakeholder engagement and management, critical situations, underlying conflicts of objectives; being able to handle escalating situations, etc. - at an early and later project stage - Focus on the most common challenges and problems in project acquisition and in operational project management. Lecturers and students share their experience; peer-to-peer learning
Topic 3: **Managing interactive, real-life pitching situations**	Managing interactive, real-life situations: - Managing internal or external data science projects, coping with challenges - Focus on communication and negotiation strategies for promoting data science projects internally and externally as

	well as for implementing data science projects successfully in terms of finances and technical aspects.

Teaching and learning		
Coursework:	**Hours**	**Hours (%)**
Contact hours	30 hrs	33.3%
Coaching	0 hrs	0%
Self-study	30 hrs	33.3%
Other	30 hrs	33.3%
Total	**90 hrs**	**100.0%**

Details on teaching and learning methods:

Teaching and learning methods: **Classroom**	The lessons focus on the basic methods and approaches of project management. In addition, the module examines real-life challenges encountered when designing and managing data science projects and provides for discussions with students. These case studies and discussions also consider the underlying methods and concepts of project management. Finally, student groups will tackle a challenging project management situation taken from current practice and present their results.
Teaching and learning methods: **Coaching**	None
Teaching and learning methods: **Self-study**	Independent study consisting of a literature review and regular online research of the relevant internet forums and blogs.
Teaching and learning methods: **Other**	Students work in groups to assume the roles of contractors (i.e. internal or external consultants) of projects, in addition to their classwork and independent study. Students then present their briefs, proposals and responses to the pitches. Students prepare their presentations based on the methods and challenges of the project and the materials they studied on their own.

Assessments (Adaptions are possible at any time.)		
Assessments	**Assessment 1**	**Assessment 2**
Type of assessment	Short essay based on ideas from the class and on the students' own work	Group work as a presentation
Evaluation type	Grades	Grades
Scope	Max. 300 words (excl. title, references, appendix)	Oral presentation plus Q&A-discussion per group

Dates	During the semester - according to the lecturer's information	During the semester - according to the lecturer's information
Weighting (if two assessments)	60% (individual grade)	40% (group grade)
Aids/materials	Yes – open source (i.e. with explicit consideration of relevant online and literature sources)	Yes – open source (teamwork, incl. use of relevant online and literature sources)

Notes on the assessments:

Language	German or English (free of choice)
Certificates	None
Attendance	Mandatory attendance on the first module day and during the group sessions (presentation, probably on the last day).

Criteria for the presentations		HSLU 33%	Emerald 33%	Externals 33%
Structure				
Well-structured content, logical design	12.5%			
Language				
Spoke clearly and was easy to understand	12.5%			
Presentation technique				
Well-presented solution	12.5%			
Creativity, originality of presentation	12.5%			
Adequate answers to questions	12.5%			
Contents				
Presentation refers to theoretical models	12.5%			
Argumentation	12.5%			
The solution is of practical relevance	12.5%			

One-page criteria		HSLU or Emerald 100%
Original thinking, independent work, and creativity	25%	
Conclusive argumentation	25%	
Use of concepts and theory	25%	
Language, structure and referencing	25%	

Teaching materials	
Literature	Basic literature: • Denning, Stephen (2018). *The Age of Agile: How Smart Companies Are Transforming the Way Work Gets Done*. New York: AMACOM. Available under: https://www.forbes.com/sites/stevedenning/2017/02/10/beyond-agile-operations-how-to-achieve-the-holy-grail-of-strategic-agility/#595a77062b6a • Laloux, Frederic (2016). *Reinventing Organizations: An Illustrated Invitation to Join the Conversation on Next-Stage Organizations*. Nelson Parker. • Rose, Doug (2016): Data Science. Create Teams That Ask the Right Questions and Deliver Real Value. Springer. S. 44-141. • Schwaber, Ken and Sutherland, Jeff (2021). *The Scrum Guide™. The Definitive Guide to Scrum: The Rules of the Game.* Available under: https://www.scrumguides.org/docs/scrumguide/v2020/2020-Scrum-Guide-US.pdf#zoom=100 Further reading (optional for those interested): • Baschera, Gian-Marco; Strebel, Sandro (2016): *From Idea to Product*. Under: https://www.zhaw.ch/storage/hochschule/institute-zentren/datalab/SDS/2016/Slides/baschera.pdf | • Denning, Stephen (2018). *The Age of Agile: How Smart Companies Are Transforming the Way Work Gets Done*. New York: AMACOM. • Laloux, Frederic (2014). *Reinventing Organizations: A Guide to Creating Organizations Inspired by the Next Stage in Human Consciousness.* Nelson Parker. • Knapp, Jake (2016). *How to Solve Big Problems and Test New Ideas in Just Five Days.* Simon & Schuster. • Opelt, Andreas; Gloger, Boris; Pfarl, Wolfgang und Ralf Mittermayr (2013). *Agile Contracts: Creating and Managing Successful Projects with Scrum.* Wiley Series in Systems Engineering and Management. • Saltz, Jeffrey S.; Shamshurin, Ivan; Crowston, Kevin (2017): *Comparing Data Science Project Management Methodologies via a Controlled Experiment.* Proceedings of the 50th Hawaii International Conference on System Science. Under: https://core.ac.uk/download/pdf/77239583.pdf • Saltz, Jeffrey S.; Hotz, Nicholas; Wild, David; Stirling, Kyle (2018): *Exploring Project Management Methodologies Used Within Data Science Teams.* Twenty-fourth Americas Conference on Information Systems, New Orleans, 2018. Under: https://aisel.aisnet.org/cgi/viewcontent.cgi?article=1124&context=amcis2018 • Rubin Kenneth S. (2012). Essential Scrum: A Practical Guide to the Most Popular Agile Process. A Practical Guide to The Most Popular Agile Process. Addison-Wesley Signature Series (Cohn).
Lecture notes	None
Online resources	Main project management blogs (selection/suggestions): • http://www.datascience-pm.com/ • http://pmtips.net • https://pmbasics101.com/blog/ • https://www.projectmanager.com/blog • http://drunkenpm.blogspot.com Main Reddit communities (selection/suggestions): • https://www.reddit.com/r/agile/ • https://www.reddit.com/r/projectmanagement/

	TED Talks (selection/suggestions): • https://blog.capterra.com/top-5-ted-talks-about-project-management/
Software	None
Other resources	As announced during the lecture period.

Digital Leadership

Module description	
Module code	W.MSCIDS_DL04.18
Module name	Digital Leadership
Most recent change	July 2021
Module concept	The block week provides development opportunities for future specialists and managers who are looking to develop a new leadership style and redesign their work environments by adopting digital, innovation-driven and collaborative approaches. Students will benefit from playful, experimental, discussion- and experience-based teaching methods as well as from the digital course components. In terms of theories and concepts, the course is closely designed around the systems and theories relating to organizations and leadership. In terms of content, the course focuses on the design of complexity and innovation capability in a digital environment, creative leadership, collaborative forms of team leadership, new generation leadership, self-management, and the ability to reflect critically on the effects that AI and workforce analytics are having on the leadership practice going forward.
Module type	General Core Elective Module
Form	Block Seminar on site
ECTS credits	3 ECTS Credits
Teaching language	English
Head	Stephanie Kaudela-Baum, Marcel Altherr
Adjunct lecturers	Peter Kels, Leila Gisin

Module positioning	
Admission requirements	Data-driven Business-Models (W.MSCIDS_DDB01.18) oder alternativ: Management of Digital Enterprise (W.MSCIDS_MDE02.18)
Recommended semester	2nd – 4th semester
Remarks	None

Module objectives	
Overall objective	The module aims to make students aware that developing digital business models around Industry 4.0/big data involves more than merely creating and applying new technologies, because these technologies strongly influence an organization’s ability to manage change and develop its human resources.

	Students understand the basic leadership principles for effectively shaping relationships in the digital workplace and can apply selected topics in their exercises based on these principles and explain them in detail while working on cases in groups. As future managers and HR professionals, students are aware of the critical issues in connection with managing personal data.
Objective: **Professional skills**	Students understand the effects that digitalization can have on an organization's structure, culture and leadership practices. Students understand the theoretical approaches to analyzing and evaluating leadership systems in digital organizations. Students are familiar with leadership instruments for creating effective relationships in a digital context, especially when it comes to developing and leading collaborative teams and fostering innovation. Students know how to lead themselves with a view to mindfully using their resources, and they are aware of their personal strengths and creative potential.
Objective: **Problem-solving and critical thinking**	Students learn to cope in ambivalent and frequently changing leadership situations and are able to develop their own leadership style in the face of increasing complexity and change. They will learn how to use appropriate tools to become more adept at solving problems.
Objective: **Method skills**	Students are able to systematically apply various management instruments (agile methods, coaching and moderation techniques, communication rules, team development methods) to identify, analyze and constructively design leadership challenges.
Objective: **Communication skills**	Students complete various exercises to develop their communication skills, in particular when expressing interests without status power (matrix leadership) and supporting creative activities.
Objective: **Interpersonal skills**	Students learn how to lead collaboratively or laterally and to develop a culture of trust in a work context shaped by digital technologies. Students learn the key aspects of managing personal data (e.g. in the context of the application of people analytics).
Objective: **Personal skills**	Students learn to develop and evaluate their strengths with a view to better gauging their personal skills. They understand the health risks (e.g. mental illness) in the working context of digital organizations.

Contents	
Topic 1: **Leadership and digital transformation – underlying theories and concepts**	Self-management and the ability to manage complexity, role concepts, systematic management and organizational development.
Topic 2: **Innovation and change leadership**	Promotion of transformational learning, creativity and innovation in high-tech companies (focus on leadership and organizational development).
Topic 3: **Collaborative leadership**	Leadership of virtual, self-managed teams; lateral leadership; leadership and power

Topic 4: **Coaching as leadership skill**	Forming a confrontation and feedback culture in flat hierarchies and dynamic work contexts, incl. the use of new communication media and the effects on management relations (participation through increased transparency in digital companies).
Topic 5: **In-depth study of leadership and change**	Agile leadership, team development in organizational forms
Topic 6: **Self-management (the future and I)**	Assessing one's strengths, self-reflecting with Lego Serious Play, developing one's career.

Teaching and learning

Coursework:	**Hours**	**Hours (%)**
Contact hours	20 hrs	22.2%
Coaching	30 hrs	33.3%
Self-study	35 hrs	39%
Other	5 hrs	5.5%
Total	**90 hrs**	**100.0%**

Details on teaching and learning methods:

Teaching and learning methods: **Classroom**	The module is offered during a **block week** (4 days). Students benefit from playful, experimental, discussion- and experience-based teaching methods and digital tools to foster collaboration.
Teaching and learning methods: **Coaching**	During the module, students will complete exercises in groups.
Teaching and learning methods: **Self-study**	Studying the literature
Teaching and learning methods: **Other**	Coaching elements (basis: Strength assessment, creativity assessment)

Assessments

(Adaptions are possible at any time.)

Assessments	**Assessment 1**	**Assessment 2**
Type of assessment	Presenting group work (as part of the block week) Blog post (2 pages) based on the group work about digital leadership (4 weeks after the block week). Selection of topic from the topic	Individual written work: A written report to reflect on personal career options derived from the assessments and observations made during the block week. (Submission date: 4 weeks after the block week)

	pool. This will start four weeks before the block week, including introductory literature. The groups can register on ILIAS.	
Evaluation type	Grades	Grades
Scope	Group presentation 15 min. (during the block week) Blog post (after the block week)	5 pages
Dates	During the block seminar - according to the lecturer's information	During the block seminar - according to the lecturer's information
Weighting (if two assessments)	50%	50%
Aids/materials		

Notes on the assessments:

Language	Blog post and individual reflection (German or English) Group presentation (English)
Certificates	None
Attendance	80% (22 lessons)

Teaching materials	
Literature	Articles / chapters. (ILIAS)
Lecture notes	See above.
Online resources	Online materials, slides, additional materials
Software	None
Other resources	None

Discrete Response, Time Series, and Panel Data

Module description	
Module code	W.MSCIDS_RTP02.18
Module name	Discrete Response, Time Series, and Panel Data
Most recent change	May 2021
Module concept	Measuring data at different points in time quickly raises a new set of questions: How does the behavior of the system change, and is it possible to predict the results of future measurements? This module explores the basic technologies with which to analyze time series data and use it for making predictions. To determine the most suitable method for tackling a particular problem, the module applies the techniques learned previously to different questions and quantifies the effect of individual decisions with a view to predicting how a measurand will develop.
Module type	Required module
Form	Regular Course (weekly)
ECTS credits	3 ECTS Credits
Teaching language	English
Head	Philipp Schütz
Adjunct lecturers	None

Module positioning	
Admission requirements	Classical and Bayesian Statistics (W.MSCIDS_SA01.18)
Recommended semester	2nd semester
Remarks	None

Module objectives	
Overall objective	Students are able to identify and quantify structures and make well-founded predictions for given time-dependent data sets by applying the steps they about learned during the module. They will independently research new methods and compare them with those from the course and then select the most suitable ones for tackling a given problem.
Objective: **Professional skills**	Students - understand the main concepts for analyzing time-dependent data

	- are able to list common methods for analyzing time-dependent data and explain how they function by referring to the underlying principles. - understand different methods for analyzing time series data - can compare different methods with regard to their suitability for solving an existing problem.
Objective: **Problem-solving and critical thinking**	Students are able to identify appropriate methods for solving a new analytical problem and to apply them and evaluate the results.
Objective: **Method skills**	Students are able to apply the presented methods to new data and interpret the results of the statistical package they used.
Objective: **Communication skills**	None
Objective: **Interpersonal skills**	Students are able to jointly identify and apply different methods to solve a problem and evaluate the results of their fellow students.
Objective: **Personal skills**	Students - are able to evaluate the results of externally analyzed data in terms of their plausibility and choice of methods. - are able to independently research additional forecasting methods for a given task and learn to use them of their own accord.

Contents	
Topic 1: **Decomposition, noise treatment**	- Types of noise, reduction of noise contributions - Decomposition and delineation of seasonality and trend effects
Topic 2: **Quantitative description**	- Dependent mass - Correlation functions
Topic 3: **Modeling**	- Linear models (AR, MA, ARMA) - Extensions (ARIMA, SARIMA) of linear models, incl. trend and seasonal effects - Non-linear models such as (G)ARCH
Topic 4: **Forecasting**	- Forecast procedures for linear models - Forecasts for models with seasonal effects and trends
Topic 5: **Panel data**	- Analytical procedures - Modeling with constant and random error contributions - Hypotheses tests for modeling
Topic 6: **Influence of sudden changes**	- Linear modeling - Maximum likelihood procedure

Teaching and learning		
Coursework:	**Hours**	**Hours (%)**
Contact hours	20 hrs	22.3%
Coaching	40 hrs	44.4%
Self-study	30 hrs	33.3%
Other		
Total	**90 hrs**	**100.0%**

Details on teaching and learning methods:

Teaching and learning methods: **Classroom**	Discussion-based lessons with exercise sequences for applying the techniques that have been learned.
Teaching and learning methods: **Coaching**	Exercises to further explore the methods by means of problem-based learning.
Teaching and learning methods: **Self-study**	None
Teaching and learning methods: **Other**	None

Assessments (Adaptions are possible at any time.)		
Assessments	**Assessment 1**	**Assessment 2**
Type of assessment	Exercises	Written examination (one part can be computer-aided)
Evaluation type	Several plausibly processed series	Grades
Scope	12 series	60 minutes
Dates	Work during the semester; submission at the end of the semester	During the official examination period
Weighting (if two assessments)	30%	70%
Aids/materials	None	Closed book

Notes on the assessments:

Language	German or English (free of choice)
Certificates	None

Attendance	None

Teaching materials	
Literature	Students will receive detailed documentation and will not need to purchase any course materials. The following works may serve as inspiration for further reading: - C. Kleiber, A. Zeileis, Applied Econometrics with R, Springer, 2008 - R. H. Shumway, D. S. Stoffer, Time Series Analysis and Its Applications, Springer, 2017
Lecture notes	None
Online resources	Complementary source: https://otexts.com/fpp2/ https://datacamp.com
Software	R with RStudio
Other resources	None

Ethical Issues of Big Data

Module description	
Module code	W.MSCIDS_EBD03.20
Module name	Ethical Issues of Big Data
Most recent change	June 2022
Module concept	Ultimately, data systems should contribute to the common good. At the same time, handling data ethically can, in itself, be a source of competitive advantage. Data systems can, however, endanger human values such as freedom, privacy, security, trust, dignity, and public welfare It is therefore essential to systematically analyse the ethical aspects of data systems, to assess the claims and rights of stakeholders, to evaluate design variants, and then to optimise them. This module provides the theoretical and practical knowledge to enable you to do this.
Module type	General Core Elective Module
Form	Regular Course (weekly)
ECTS credits	3 ECTS Credits
Teaching language	English
Head	Bruno Frischherz
Adjunct lecturers	Gordon Millar

Module positioning	
Admission requirements	
Recommended semester	3rd Semester
Remarks	

Module objectives	
Overall objective	The students analyse and evaluate data systems from an ethical perspective. They know which values are particularly endangered and/or can be promoted by data systems (autonomy, privacy, fairness, etc.)
Objective: **Professional skills**	Students are familiar with the approaches and concepts of data ethics, algorithm ethics and Corporate Digital Responsibility (CDR). They know the criteria for assessing ethical conflicts in connection with data systems.

Objective: **Problem-solving and critical thinking**	The students can evaluate different design variants according to ethical criteria.
Objective: **Method skills**	Students can apply a rational and structured approach to analysing and solving ethical conflicts between the claims of different stakeholders.
Objective: **Communication skills**	The students can conduct a stakeholder dialogue to identify their interests, rights and claims.
Objective: **Interpersonal skills**	The students can assess the contribution of data systems to the common good.
Objective: **Personal skills**	The students are able to reflect on their own ethical values in the context of data generation and handling.

Contents	
Topic 1:	Digital society and ethics _ digitization of all areas of life _ general and digital ethics – schools of thought _ relevant values: freedom, privacy, security, health, sustainability, property, trust, dignity, public welfare, etc. _ technology assessment
Topic 2:	Data Ethics _ principles, guidelines and requirements _ code of ethics for data-based value creation _ harm avoidance, justice, autonomy _ control, transparency, accountability _ privacy: definition, function _ people analytics
Topic 3:	Algorithm Ethics _ machine and algorithm ethics _ value-based design _ ethical stakeholder analysis and dialogue _ autonomy and automated decisions _ trustworthy AI, non-discrimination and fairness _ transhumanism
Topic 4:	Corporate Digital Responsibility (CDR) _ from CSR to CDR _ dimensions of responsibility _ technology for the Sustainable Development Goals _ CDR management - an integrated model

	_ ethical dilemmas in the professional environment _ ethics as a competitive advantage

Teaching and learning		
Coursework:	**Hours**	**Hours (%)**
Contact hours	30 h	33 %
Coaching	10 h	11 %
Self-study	50 h	56 %
Other		
Total	**90 hrs**	**100.0%**

Details on teaching and learning methods:

Teaching and learning methods: **Classroom**	Dialogue-oriented teaching
Teaching and learning methods: **Coaching**	Exercises for deepening understanding and its application to case studies
Teaching and learning methods: **Self-study**	Exercises for deepening understanding and its application to case studies
Teaching and learning methods: **Other**	---

Assessments

(Changes are possible at short notice.)

Assessments	**Assessment 1**	**Assessment 2**
Type of performance record	Case solution (pair work)	
Evaluation type	Graded	
Page count	8-10 pages	
Date	During the semester - according to the lecturers' briefing	
Weighting	100%	

(if two assessments)		
Aids/materials	Open book	

Notes on the assessments:

Language	German or English (free coherent choice)
Certificates	n/a
Attendance	80% attendance requirement

Teaching material	
Literature	Data Innovation Alliance (ed.). (2020). Code of Ethics for Data-Based Value Creation. https://data-innovation.org/data-ethics/ DataEthics. (2018). DataEthics. Principles and Guidelines for Companies, Authorities & Organisations. https://dataethics.eu/data-ethics-principles/ European Commission. (2020). White Paper. On Artificial Intelligence—A European approach to excellence and turst. https://ec.europa.eu/info/sites/info/files/commission-white-paper-artificial-intelligence-feb2020_en.pdf Floridi, L., & Taddeo, M. (2016). What is data ethics? https://royalsocietypublishing.org/doi/pdf/10.1098/rsta.2016.0360 Hasselbalch, G., & Tranberg, P. (2016). Data ethics: The new competitive advantage. Publishare. High-Level Expert Group on AI (2019). *Ethics guidelines for trustworthy AI* . Digital Single Market - European Commission. https://ec.europa.eu/digital-single-market/en/news/ethics-guidelines-trustworthy-ai Spiekermann, S. (2016). Ethical IT innovation: A value-based system design approach. CRC Press. Stanford Encyclopedia of Philosophy. https://plato.stanford.edu/
Lecture notes	Slides, exercises, case studies
Online resources	ACM Special Interest Group Computers & Society: http://www.sigcas.org/ Council for Big Data, Ethics, and Society: https://bdes.datasociety.net/ IEEE Global Initiative on Ethics of Autonomous and Intelligent Systems: https://ethicsinaction.ieee.org/
Software	---
Other resources	---

Fraud Detection

Module description	
Module code	W.MSCIDS_DE_FRD01.20
Module name	Fraud Detection
Most recent change	December 2022
Module concept	The progress in digitalization and more persistent threats (e. g. cybercrime) contribute to increasing fraud being committed with technically easier means but being more difficult to identify and mitigate. In order not to jeopardize the value of data analyses, it is vital to fight fraud with appropriate strategies, tools, solutions, and processes, at high quality. In this module, the students will be inducted to the requirements and technologies needed for successful detection of and protection against fraud typically existing in the financial industry like insurances and banks. The learning blocks will consist of introductory lectures leading to supervised group work, where the students will generate in-depth understanding that is shared within and across the groups. A lab exercise will provide hands-on experience, so students are prepared to implement their knowledge in practice.
Module type	Core Elective Module – Domain Experience
Form	Regular Course (weekly)
ECTS credits	3 ECTS Credits
Teaching language	English
Head	Prof. Dr. Peter E. Fischer
Adjunct lecturers	Guest lecturers (financial industry expert, lab instructor), MSc theses candidates

Module positioning	
Admission requirements	none
Recommended semester	none
Remarks	

Module objectives	
Overall objective	Students - Learn a basic understanding of fraud detection methodologies incl. information security and risk mana - Gain practical experience in analyzing data related to fraud detection and are enabled to setup appropriate strategies, systems, and procedures - Understand the importance of awareness in information security, risk management and dealing with fraud, ideally also a basic knowledge of forensics

Objective: **Professional skills**	- Information security, risk management, basic forensics and incident response, basic knowledge management - Requirements, strategies, tools, solutions, implementation, detection of and protection against fraud - System design, prototyping, testing, and re-engineering
Objective: **Problem-solving and critical thinking**	- Analytical thinking - Problem recognition, structuring and solving - Decision-making processes
Objective: **Method skills**	- Fraud Detection - Design Thinking - Digital analytics - Value propositions
Objective: **Communication skills**	- Written and oral interaction, active listening - "Language" of the industry - Professional documentation, presentations, and defense
Objective: **Interpersonal skills**	- Teamwork - Reflections and finding of compromises - Working under sub-optimal conditions (e.g. online) - Negotiations and decision making
Objective: **Personal skills**	- Self-esteem - Analytical and synthetical thinking - Structured reasoning and processing - Dedication, effectivity, and efficiency

Contents	
Topic 1:	**Introduction:** Definitions, needs, basics, security, vulnerabilities, threats, risks, motivation
Topic 2:	**Strategies**: Basics, fraud detection techniques, artificiel intelligence
Topic 3:	**Tools**: Security operations, protection & counter defeat, Incident Response & IT Forensics processes
Topic 4:	**Solutions**: Product suppliers and products, evaluation options, solution providers
Topic 5:	**Lab Exercise**: Hands-on fraud detection, evaluation of a simple Fraud Detection engine (focus Incident Response & Forensics)
Topic 6:	**Guest Lecture**: Challenges, approaches and experiences from an expert in the field
Topic 7:	**Presentations**: Presentations of wikis

Teaching and learning		
Coursework:	**Hours**	**Hours (%)**
Contact hours	20 h	22
Coaching	30 h	34

Self-study	40 h	44
Other		
Total	**90 h**	**100.0%**

Details on teaching and learning methods:

Teaching and learning methods: **Classroom**	Dialog oriented lectures and (group) discussions
Teaching and learning methods: **Coaching**	Group work to elaborate depth into topics, creation of content for wiki and / or term papers
Teaching and learning methods: **Self-study**	Generic and topic-specific deepening with publicly available literature. Design Thinking for MSc Thesis, personal reflection
Teaching and learning methods: **Other**	Ad hoc

Assessments

(Adaptions are possible at any time.)

Assessments	**Assessment 1 (Group)**	**Assessment 2 (Personal)**
Type of performance record	Group wikis based on lectures plus individual extensions (rather free scoping)	Personal contribution to wikis (must be marked and character counted), personal reflection, lessons learned, feedback
Evaluation type	Grades (overall quality group-wise) on wiki (incl. presentation)	Grades (personal contributions via bonus / malus) on wiki (incl. presentation)
Scope	Ca. 30-40'000 characters per student plus graphics, tables and reference pages etc.	About 2'000 characters per students (personal reflection, lessons learned, feedback)
Date	During the semester - according to the professor's information (see instruction on Ilias)	During the semester - according to the professor's information (see instruction on Ilias)
Weighting	75%	25%
Aids/materials	Wiki comparison (Wikipedia)	At the end of the group wiki

Notes on the assessments:

Language	Wiki EN (or DE), personal reflection EN (or DE)
Certificates	None
Attendance	80% attendance requirement

Teaching material	
Literature	https://www.coursera.org/learn/information-security-data https://www.coursera.org/learn/cyber-security-domain/ (optional) https://www.coursera.org/learn/forensic-accounting
Lecture notes	Slide decks will be made available on Ilias, no scripts!
Online resources	Mostly students will search for online information as part of their group work. Others provided ad hoc.
Software	- Linux and Windows VMs by Enterprise Lab - Splunk Server and other analytic tools - Trial versions of commercial analyzers if accessible - Wiki software (e.g. Confluence by Atlassian)
Other resources	Lab Exercise "Fraud Detection", HSLU-I

Geospatial Data Analysis for Smart Communities

Module description	
Module code	W.MSCIDS_DE_GD01.18
Module name	Geospatial Data Analysis for Smart Communities
Most recent change	December 2022
Module concept	In the course of globally advancing digitalization, more and more extensive data worlds are being created that pertain to particular locations. This includes, for example, information relating to municipal boundaries, postcodes, hectares, or point data (coordinates) as used in a wide range of spatial, mobility and societal contexts. But how can space be captured in data in the first place? What is the point of visualizing the differences between urban and rural populations in the form of thematic maps? And what is the benefit of analyzing the patterns of mobile phone movements? Such questions play a particularly important role in *smart cities* and *smart communities*, which include more than a merely urban context. The *Geospatial Data Analysis for Smart Communities* module introduces students to the principles and variety of spatial data used in Switzerland. Its aim is to enable students to use spatial data in order to create simple, personal cartographic representations in connection with mobility as well as spatial and societal aspects. Students will use the maps their own maps to evaluate the differences and dynamics in georeferenced data and to formulate and evaluate the goals and potentials of *smart communities*.
Module type	Core Elective Module – Domain Experience
Form	Regular Course (weekly)
ECTS credits	3 ECTS Credits
Teaching language	English
Head	Timo Ohnmacht
Adjunct lecturers	Stefan Lüthi, Michael Giesch, Martin Tschopp, Yves Maurer, Balz Bodenmann, Jonas Bubenhofer, Michael Balmer, Arthur Clement, Silke Zöllner

Module positioning	
Admission requirements	none
Recommended semester	none
Remarks	none

Module objectives	
Overall objective	Students have an overview of the type and variety of spatial data available in Switzerland and of the applications used for processing such

	data. They are able to use the data to make statements about spatial or social trends.
Objective: **Professional skills**	They are able to prepare simple spatial data and convert it into simple thematic maps by relying on various background maps to make the new version (e.g. alpine relief, lakes, rivers, borders) more attractive visually.
Objective: **Problem-solving and critical thinking**	They are able to interpret the data in the context of *smart communities*.
Objective: **Method skills**	They are able to link all of the various types of georeferencing data (Swiss national coordinates, WGS-84 etc.).
Objective: **Communication skills**	They understand visualization of data as a means of communication and can evaluate its success.
Objective: **Interpersonal skills**	They are able to complete a project based on what they have learned and without external help. They are able to gauge the opportunities, risks and problems of the results while working in groups.
Objective: **Personal skills**	Students have an overview of the type and variety of spatial data available in Switzerland and of the applications used for processing such data. They are able to use the data to make statements about spatial or social trends.

Contents	
Topic 1: **Principles of the topic**	Significance and potential of data and its implications for *smart communities*. The topic aims to further build awareness of *smart communities* and their effect on society, politics and the environment.
Topic 2: **Principles of georeferencing**	Participants will use databases and statistics to learn about different types of underlying data and to examine the possibilities derived from the use of such material.
Topic 3: **Simulations**	Participants will use a range of models (FaLC, Senozon, 3D model of the city of Lucerne) to develop simulations for practical purposes and to define specific areas of application.
Topic 4: **Movement patterns**	The topic examines the general conditions, possibilities and limits of the technology based on the example of mobile phone location signals.
Topic 5: **Examples of spatial data used for political purposes**	The topic highlights the role of data in understanding and planning mobility concepts, developing and accessing particular locations, designing transport infrastructure, and completing regional development projects.
Topic 6: **Data preparation**	Cartographic representations with QGis and data preparation with R: An introduction to the instruments used in the supervised term paper.

Teaching and learning		
Coursework:	**Hours**	**Hours (%)**
Contact hours	30 hrs	33.3%
Coaching	30 hrs	33.3%
Self-study	30 hrs	33.3%
Other		
Total	**90 hrs**	**100.0%**

Details on teaching and learning methods:

Teaching and learning methods: **Classroom**	Discussion-based lessons with current examples and applications
Teaching and learning methods: **Coaching**	Preparations for the lessons and solving case examples or other tasks
Teaching and learning methods: **Self-study**	Written group work
Teaching and learning methods: **Other**	None

Assessments (Adaptions are possible at any time.)		
Assessments	**Assessment 1**	**Assessment 2**
Type of assessment	Concept for the term paper	Supervised term paper in groups of up to four
Evaluation type	Grades	Grades
Scope	Max. 8 pages	Term paper of 10-15 pages
Dates	During the semester - according to the lecturer's information	During the semester - according to the lecturer's information
Weighting (if two assessments)	30%	70%
Aids/materials	None	None

Notes on the assessments:

Language	German or English (free of choice)

Certificates	None
Attendance	Yes

Teaching materials	
Literature	Various descriptions of data collections and software use.
Lecture notes	Verkehr: Verkehrsmodell des Bundes (VM-UVEK) RIS: Rauminformationssystem der Schweiz ARE WEB GIS: https://map.geo.admin.ch BFS: Volkszählung: Beschäftigte und Einwohner nach Hektarraster Betriebs- und Unternehmensregister (BUR) QGIS: https://www.qgis.org/de/site/
Online resources	QGIS, Microsoft Excel, R, ARE WebGis, FaLC, Senozon Mobility model, 3D model of the city of Lucerne
Software	None
Other resources	Various descriptions of data collections and software use.

Global School of Empirical Research Methods

Module description	
Module code	W.MSCIDS_GSERM01.19
Module name	Global School of Empirical Research Methods
Most recent change	April 2021
Module concept	The GSERM Global School in Empirical Research Methods is a high-calibre integrated generic programme on methodology launched by the University of St. Gallen. We welcome Master, PhD students, Post-Docs and also practitioners from all kinds of study fields and industries collecting data and analysing in different methods of statistics. You enhance your skills in block seminars taught by world-class faculty amongst an international crowd of participants. At different locations in Europe we offer courses in quantitative and qualitative statistics. Courses are offered from basic up to advanced level. Accommodation is offered and can be booked at an additional cost. Find out more: https://www.gserm.ch/stgallen/
Module type	General core elective module
Form	External Course
ECTS credits	4 ECTS Credits (only one course can be credited to the master's programme)
Teaching language	English
Head	Andreas Herrmann
Adjunct lecturers	None

Module positioning	
Admission requirements	None
Recommended semester	None
Remarks	None

Contents	
	Find all current courses on https://www.gserm.ch/stgallen/courses/

Hands-on Visualisation for Data Science

Module description	
Module code	W.MSCIDS_HVD03.22
Module name	Hands-on Visualisation for Data Science
Most recent change	May 2023
Module concept	Data visualization is a powerful tool to explore, understand and communicate patterns in quantitative information. It demands three quite different skills: substantive knowledge, statistical skill, and artistic sense. This course is intended to introduce participants to crucial data acquisition, design principles, and visualization techniques for the exploration and presentation of data. This course emphasizes the practical aspects of data visualization using different datasets and contexts within a cloud environment. This course will introduce the main concepts of visual analytics hands-on using visualization tools (i.e., Tableau). The students will design their use cases, and at the end of this course, they are expected to be able to create dashboards to answer the business questions for use cases.
Module type	General Core Elective Module
Form	Regular Course (weekly)
ECTS credits	3 ECTS Credits
Teaching language	English
Head	Luis Terán / José Mancera
Adjunct lecturers	

Module positioning	
Admission requirements	Open to any student willing to improve their data visualization skills
Recommended semester	Any semester
Remarks	This module is appropriate for students that want to boost their visualization skills based on best industry practices and use cases.

Module objectives	
Overall objective	Enable data scientists/engineers to integrate and analyze data. The course offers also hands-on sessions and presents implementations made in business practice.
Objective: **Professional skills**	• Fundamentals of data visualization and design. • Data visualization selection based on the goal of the analysis.

	• Identify the limitations and biases in data that affect the recommendations. • Building on your ghost deck • Final presentation with final recommendations and an executive summary
Objective: **Problem-solving and critical thinking**	• Identify the different data story types and how to find and use them to tell interesting data stories. • Define
Objective: **Method skills**	• Create a "ghost deck" — a skeleton deck commonly used by management consultants to identify a client's needs • Understand different techniques and strategies to deal with data. • Visualization tool selection strategy based on data sources
Objective: **Communication skills**	• Clearly articulate and communicate a problem statement for a data project • Clearly articulate the "so what" of your analysis.
Objective: **Interpersonal skills**	• Function effectively in the group • Exchange feedback with peers
Objective: **Personal skills**	• Be able to work on practical topics on one's own and gauge and further develop the ability to learn independently • Submit results on time and further develop the ability to manage workloads and deadlines independently as needed

Contents	
Session 1:	Intro to Data Visualization • Projects descriptions • Group creation • Data Visualization Fundamentals Responsible lecturer : Luis Terán
Session 2:	Design Principles • Exploratory Vs Explanatory • Chart junk • Design integrity • Unsing color • Good visual Responsible lecturer: Luis Terán
Session 3:	Creating Visualizations in Tableau: • What is Tableau • Conencting to data • Combinind data • Worksheets • Agregations and hierarchies

	• Marks and filters Responsible lecturer: Luis Terán
Session 4:	Planning phase: • Audince attributes • Dashbords • Pulling data from priorities • Statement of work Responsible lecturer: José Mancera
Session 5:	Design phase: • Graphicacy • Chart choice • Visual hierarchy • Wireframing • Layouts Responsible lecturer: José Mancera
Session 6:	Dashboards in Production • Color • Interactivity • Annotations Responsible lecturer: José Mancera / Luis Terán
Session 7:	Industry dashboard desings • Industry use-cases. Responsible lecturer: José Mancera

Teaching and learning		
Coursework:	**Hours**	**Hours (%)**
Contact hours	30 hrs	33.3%
Coaching	30 hrs	33.3%
Self-study	30 hrs	33.3%
Other		
Total	**90 hrs**	**100.0%**

Details on teaching and learning methods:

Teaching and learning methods: **Classroom**	Introduction to the module's design and the semester Lectures on the various topics as an introduction Students present the status of their project and discuss them in groups

Teaching and learning methods: **Coaching**	Guided project work, use cases and mini projects.
Teaching and learning methods: **Self-study**	Students will work on individual data projects that will give them the possibility to apply all the learned skills.
Teaching and learning methods: **Other**	

Assessments
(Adaptions are possible at any time.)

Assessments	**Assessment 1-3**
Type of performance record	3 Mini Projects
Evaluation type	Grades
Scope	Every assignment has a specific rubric and learning goals. Mini - Projects will be conducted during the semester and **evaluated individually at the end of the semester by the lecturers.** **No feedback or preliminary evaluation can be provided between mini projects**.
Date	Generous deadlines will be given and agreed with students in the semester.
Weighting	All assessments combined is 100%
Aids/materials	All legitimate aids are permitted

Notes on the assessments:

Language	English
Certificates	n/a
Attendance	highly recommended but lectures will be streamed.

Teaching material

Literature	Hands-On Data Visualization By Jack Dougherty, Ilya Ilyankou • Mastering Tableau 2021 - Third Edition By Marleen Meier, David Baldwin, Kate Strachnyi

	• Tableau Desktop Certified Associate: Exam Guide By Dmitry Anoshin, JC Gillet, Fabian Peri, Radhika Biyani and Gleb Makarenko • Storytelling with Data: A Data Visualization Guide for Business Professionals By Cole Nussbaumer Knaflic
Lecture notes	The material will be provided every week
Software	Tableau
Infrastructure	Amazon AWS Services / Tableau Cloud
Other resources	

Human Centered Design

Module description	
Module code	W.MSCIDS_HCD02.18
Module name	Human Centered Design
Most recent change	June 2021
Module concept	Data scientists are the hottest thing on the market, making logical decisions, calculations and presentations. So why should you, as an aspiring data scientist think in a human-centered way? Because every data point is either created, interpreted or acted upon by humans. And as much as we would like our world to be logical – it is not. You will spend time learning about the design mindset, design thinking, and related methodologies in an engaging, and (dare I say) fun way. This will enable you to place people at the center of data acquisition, data processing, data analysis and application of data. The aim is to ensure that the work of data scientists serves both human-level and organizational needs, and that people do not get lost in the data.
Module type	Generalist core elective module
Form	Regular Course
ECTS credits	3 ECTS Credits
Teaching language	English
Head	Peter Horvath
Adjunct lecturers	

Module positioning	
Admission requirements	None
Recommended semester	2nd semester
Remarks	None

Module objectives	
Overall objective	In the Human Centered Design module, you will learn how to adopt a human-centered approach to your existing activities and processes, as well as how to select and use appropriate design methods and tools. The module builds upon the Data Ideation module, but is completely self-contained. The involvement of end-users (i.e. actual people) constitutes an essential part of Human Centered Design. To this end, students will plan, conduct and moderate workshops and evaluate the results, in addition to doing research, conducting analyses and presenting findings.

	You will participate in various co-creative activities during classes, with a special attention on qualitative research and physical and virtual workshops. You will work on a hands-on project as part of a team. But wait, there's more! What you learn will be put into practice during the course in your most important project: your life!
Objective: **Professional skills**	1. Understand the design process on a macro level, and use its tools on a micro level. 2. Identify and visualize the range of external and internal stakeholder groups, and be able to gauge and evaluate their requirements. 3. Define a project from a user perspective by selecting and applying human-centered research and design methods.
Objective: **Problem-solving and critical thinking**	1. Question initial project assumptions. 2. Compare the results of quantitative data analysis with the needs of user groups and internal stakeholders. 3. Applying human-centered design methods to better answer project questions, and define further project questions.
Objective: **Method skills**	1. Understand the structured approach to the human-centered design process, its phases and the corresponding methods. Apply and adapt methods to various projects. 2. Define a project-specific design process, plan and execute human-centered design methods. 3. Be able to define, explain and revise the steps in the project; and reflect upon, categorize and evaluate the results.
Objective: **Communication skills**	1. Be able to directly engage with end-users in user research, and be the voice of the customer within projects, or the organization. 2. Be able to defend your own work during a discussion, and offer supportive and thoughtful arguments and criticism to others. 3. Be able to visualize and present results by taking into account the target group's expectations.
Objective: **Interpersonal skills**	1. Be able to cooperate with and across various domains. Compare the insights gained through qualitative data analysis with the needs of stakeholders as evaluated by means of human-centered design methods. 2. Improved cooperation with other teams; Learn how to include end-users in projects. 3. Use collaborative aspects of the project, e.g. planning, implementing (moderating) and following-up on workshops with user groups and internal stakeholders.
Objective: **Personal skills**	1. Be able to self-reflect, critically reflect of your own position and role, and evaluate the critique of others. 2. Gain empathy to understand end-users, stakeholders and beneficiaries of a project. Coordinate and evaluate various stakeholder positions and attitudes. 3. Plan your own career.

Contents	
Topic 1:	Understand the relevance of human-centered design for data science.
Topic 2:	Understand the mindset, concepts, processes and methods of human-centered design, along with its trends and criticism.
Topic 3:	Understand the tools of the design process in detail, select and apply the right methods to specific phases of a project.

Teaching and learning		
Coursework:	**Hours**	**Hours (%)**
Contact hours	30 hrs	33.3%
Coaching	30 hrs	33.3%
Self-study	30 hrs	33.3%
Other		
Total	**90 hrs**	**100.0%**

Details on teaching and learning methods:

Teaching and learning methods: **Classroom**	Interactive, engaging, co-creative. During our time together we will try to place emphasis on discussion, dialogue, and critique.
Teaching and learning methods: **Coaching**	Plan and execute workshops with user groups independently for student projects.
Teaching and learning methods: **Self-study**	To prepare for classroom interaction, familiarize yourself with the core material using original content provided for the course, and content from academia and practitioners.
Teaching and learning methods: **Other**	Blended learning, co-creation, classroom engagement

Assessments (Adaptions are possible at any time.)		
Assessments	**Assessment 1**	**Assessment 2**
Type of assessment	Plan your career using an iterative, human-centered design process, in multiple steps.	Documentation on planning, conducting and evaluating a workshop. You and your group will plan a workshop on a topic of selected in class. You will determine the process, select the methods, conduct the workshop,

		evaluate the results, and present this as a report.
Evaluation type	Grades	Grades
Scope	Approx. 2,000 characters (without spaces), illustrations, visualizations	Maximum. 2,000-4,000 words; illustrations, visualizations of the process and methods, evaluation of the results
Dates	During the semester - according to the lecturer's information	During the semester - according to the lecturer's information
Weighting (if two assessments)	30%	70%
Aids/materials		

Notes on the assessments:

Language	English
Certificates	None
Attendance	80%

Teaching materials	
Literature	Curedale, R. (2013), Service Design – 250 Essential Methods Young, I. (2008). Mental Models Kalbach, J. (2016), Mapping Experiences Kolko, J. (2012), Wicked Problems – Problems Worth Solving Lewrick, M. et al. (2018). Das Design Thinking Playbook Lewrick, M. et al. (2019). Das Design Thinking Toolbook Portigal, S. (2013), Interviewing Users Stickdorn, M. et al. (2018). This is Service Design Doing Stickdorn, M. et al. (2014). This is Service Design Thinking Übernickel, F. et al. (2016). Design Thinking Handbuch Audrey Crane (2019). What CEOs need to know about design Matt Wattkinson (2012). The 10 Principles of Great Experience Design Louise Dorn (2020). Good Services
Lecture notes	No
Online resources	becreate.ch designkit.org//resources/1 dschool.stanford.edu/resources diytoolkit.org/download-diy-toolkit/ servicedesigntools.org
Software	None
Other resources	None

IBM Watson Chatbot Challenge

Module description	
Module code	W.MSCIDS_IBM01.21
Module name	IBM Watson Chatbot Challenge
Most recent change	December 2022
Module concept	Conversational artificial intelligence (AI) is no longer science fiction, but an increasingly mainstream capability with which consumers interact daily in their homes, workplaces, and on the go. Usually known as bots, chatbots, or virtual assistants, this conversational AI makes up a crowded and confusing enterprise market, leading buyers with many "bot" versions that may not talk to each other effectively. Watson Assistant is IBM's virtual assistant solution that allows users to interact with business systems using natural human language. IBM has married a technically robust conversational platform with developer and line-of-business-friendly tools with the breadth of the broader Watson portfolio. Enterprises can build and train the AI solution to serve a wide range of use cases across applications, devices, and channels. The module aims are to design enterprise-specific conversational use cases and implement them using state-of- the-art frameworks of IBM Watson Assistant. You will get insights into the conversational design, natural language processing (NLP) in general and specifically in natural language understanding (NLU) and generation (NLG) as well as dialogue design . Further, you will get a glimpse into machine learning and knowledge engineering depending on the group project requirements and students preferences. The assessment is a group project focussing in a cross-functional team on a provided or real use case and a prototypical implementation during the course. These virtual assistants aim to create and solve a real business case of real companies. They are presented and evaluated by the companies at a final presentation. In this independent study module, 20% of the classroom time will be coaching; the first two sessions will be classical/directed input and hands-on lecture; later the learning is self-directed by working on the group work. A mid-term checkpoint to ensure the milestones of the project are on track.
Module type	General core elective module
Form	Regular Course (weekly)
ECTS credits	6 ECTS Credits
Teaching language	English
Head	Dean Heizmann, Mario Locher
Adjunct lecturers	Lars Mallien, Dorothée Reinhard, Andreas Martin, Mathias Chavanne, Nina Fischer, Youri Boehler, Lukas Steiner

Module positioning	
Admission requirements	none
Recommended semester	open
Remarks	none

Module objectives	
Overall objective	• Students can explain conversational systems by using conversational terms such as: entities, intents, utterances, context, slots/parameters, actions, dialogue design, disambiguation, digression, events, response, broadcast/push notifications and fulfilment • Students can describe how knowledge-based systems and knowledge engineering could help to increase the natural language understanding (NLU) • Students can describe how machine learning, intent matching, entity extraction, dialogue design and context can increase the user experience and containment • Students can identify and solve a business case applying the Enterprise Design Thinking methodology, can train and integrate a virtual assistant • Students identify the cost, benefit, flexibility, and risk factors that affect the investment decision, can explain ROI and indicate the PV, NPV
Objective: **Professional skills**	• Students can execute a requirements elicitation phase for an AI-powered virtual assistant • Students can design and construct a conversational system • Students develop a data model • Students train the virtual assistant with client data • Students can construct and implement a conversational AI prototype, pilot or proof-of-concept • Students can integrate backend services or APIs in the client environment or external webpage • Students can address and integrate virtual assistant systems and other channels • Students solve a client use case
Objective: **Problem-solving and critical thinking**	• Students can identify use case by exercising Enterprise AI Design Thinking • Students should be able to analyze and answer complex questions about the structure and dynamics of conversational flows • Students can justify an overall conversational architecture based on a prior requirements analysis and/or design process • Students should be able to assess the strengths and weaknesses of their work • Students can outline further implementation flavors • Students can identify potential for further enhancements of the virtual assistant depending on the use case (e.g. encorporating further Watson Services, connecting to an IVR system, adding more user

	languages, preprocessing the user utterance, process automation, incorporating webservices, etc.)
Objective: **Method skills**	• Understand and apply the core concepts of conversational analysis by structuring and infusing the data into Watson Assistant • Solve a business case by identifying the appropriate tools and services that support a user-oriented solution • Students can communicate best practices for building a conversational AI solution • Students understand the client's requirements and know how to translate those into milestones • Students can manage the client's expectations • Students can demonstrate and explain their solution to a non-technical audience
Objective: **Communication skills**	• Students can communicate best practices for building a conversational AI solution • Students understand the client's requirements and know how to translate those into milestones • Students can manage the client's expectations • Students can demonstrate and explain their solution to a non-technical audience
Objective: **Interpersonal skills**	• Students can investigate self-directedly further machine learning and/or knowledge engineering methods based on the conversational scenario • Students will work cooperatively within their teams in order to solve the business problem together • Students will take over responsibility and accountability for the work that they have committed themselves

Contents	
Topic 1: Motivation and history	• Enterprise AI Design Thinking • AI and non-AI Methods for Chatbot/Virtual Assistant • Conversational AI and Bot Lifecycle • Conversational Design and Engineering Process • Use Case Ideation and/or Requirements Gathering • Conversational and User Experience (UX) • General approach to Cognitive Computing - Cognitive Computing flavours • Introduction into Piloting and MVP • Integration of Conversational Channels • Introduction into Watson Assistant
Topic 2: Core concepts and methods	• Fundamental concepts of AI • Provision of service instances in IBM Cloud account • Introduction to Watson Assistant main concepts • Conversational Prototyping and Implementation • Data model (Intents & Entities) • Ground truth (Training Data) • Basic Conversational dialogue design • Designing Multi-turn interactions • Optional: Search Skill • Decision trees and dialog features • Conversational Service Integration and Fulfillment

Topic 3: Advanced topics	• Programing User Interface • REST API calls • Analytics and conversation analysis • Integration (Chat Widget / Webhooks) • Handing over the conversation to an agent (Triage) • Connecting other Watson Services for preprocessing data • Testing methods for accuracy and containment
Topic 4: Application	• Introduction to Watson Conversation concepts • Chatbot Challenge Introduction and description • Client introduction • Instructions (Cooperation with client / Professors) • Criteria's to evaluate each team • Collecting use case requirements • Managing expectation • Defining goals and milestones

Teaching and learning		
Coursework:	**Hours**	**Hours (%)**
Contact hours	20 hrs	10%
Coaching	20 hrs	10%
Self-study	140 hrs	80%
Other	n/a	n/a
Total	**180 hrs**	**100.0%**

Details on teaching and learning methods:

Teaching and learning methods: **Classroom**	Presentation of core concepts and best practices through lectures and interactive discussion.
Teaching and learning methods: **Coaching**	Guided hands-on exercises using Watson Assistant. Exchange with Professors and IBM responsibles.
Teaching and learning methods: **Self-study**	Group project work and reading background material
Teaching and learning methods: **Other**	n/a

Assessments (Adaptions are possible at any time.)			
Assessments	**Assessment 1**	**Assessment 2**	**Assessment 3**
Type of performance record	Project mid-status	Project presentation & Artefact	Final Report
Evaluation type	Grade	Grade	Grade
Scope	Core concepts of the first half of the module. Group work	The complete analytical process question formulation, data acquisition, result presentation. Group work.	Final report with theoretical basis, findings, recommendation for action. Group work
Date	During the semester	End of module	End of module
Weighting (if two assessments)	University specific	University specific	University specific
Aids/materials	None	None	none

Notes on the assessments:

Language	English
Certificates	n/a
Attendance	20% attendance requirement (introduction days and final presentation)

Teaching material	
Literature	Slides with methodological requirements and optional further readings will be handed out to students at the beginning of the semester.
Lecture notes	n/a
Online resources	Watson Assistant, Watson Discovery
Software	Watson Assistant, Watson Discovery, and other IBM Cloud Services

Legal Issues of Big Data

Module description	
Module code	W.MSCIDS_LBD03.20
Module name	Legal Issues of Big Data
Most recent change	July 2020
Module concept	Data systems can endanger human values such as privacy, security, independence, trust, transparency, etc. It is therefore essential to systematically analyse legal aspects of data systems from a data protection and fundamental rights perspective, to assess the claims and rights of stakeholders, to evaluate design variants and to optimise them. This module provides the theoretical and practical knowledge for this.
Module type	Gerneral Core Elective Module
Form	Regular Course (weekly)
ECTS credits	3 ECTS Credits
Teaching language	English
Head	Reto Fanger
Adjunct lecturers	

Module positioning	
Admission requirements	None
Recommended semester	3rd Semester
Remarks	None

Module objectives	
Overall objective	The students analyse data systems from a data protection and fundamental rights perspective. The students describe and evaluate illegal or conforming design variants and behavior.
Objective: **Professional skills**	The students know legal aspects which are affected by data systems. Students are familiar with the basic principles of data protection laws in Switzerland and the EU. Students know Big Data-specific approaches and concepts of data protection.

Objective: **Problem-solving and critical thinking**	The students evaluate different design variants under data protection and fundamental rights aspects.
Objective: **Method skills**	Students use a structured approach to identify, analyse and decide on data protection and fundamental rights conflicts between claims of different stakeholders.
Objective: **Communication skills**	Students conduct stakeholder dialogue to identify their interests, claims and rights.
Objective: **Interpersonal skills**	The students assess the contribution of a data system to the common good.
Objective: **Personal skills**	Students are aware of the importance of privacy and the fundamental right to informational self-determination in the context of big data analysis.

Contents	
Topic 1:	General Data Protection requirements _Legal Basis (consent, overriding personal or public interest) _Purpose-related _Proportionality, Data Economy (Data Minimization) _Transparency
Topic 2:	Data Protection Rights of data subjects _Right to Information _Right of Rectification _Right to Block _Right of Deletion/Forgetting _Right to Data Portability
Topic 3:	Big Data-specific Data Protection aspects _Anonymisation/Pseudonymisation _Profiling and Privacy Impact Assessment _Data Portability _Privacy by Design and Privacy by Default
Topic 4:	Other Fundamental legal aspects of Big Data _Violation of the Freedom of Iinformation _ Restriction of the Freedom of Personality and Movement

Teaching and learning		
Coursework:	**Hours**	**Hours (%)**
Contact hours		
Coaching		
Self-study		
Other		
Total	**90 hrs**	**100.0%**

Details on teaching and learning methods:

Teaching and learning methods: **Classroom**	
Teaching and learning methods: **Coaching**	
Teaching and learning methods: **Self-study**	
Teaching and learning methods: **Other**	

Assessments
(Adaptions are possible at any time.)

Assessments	**Assessment 1**	**Assessment 2**
Type of performance record	Written examination	
Evaluation type	Grade	
Scope	60 Minutes	
Date	During the official examination period	
Weighting (if two assessments)	100%	
Aids/materials	Open Books	

Notes on the assessments:

Language	German or English (free of choice)
Certificates	n/a
Attendance	80% attendance requirement

Linear Algebra 1

Module description	
Module code	W.MSCIDS_LIA01.22
Module name	Linear Algebra 1
Most recent change	May 2023
Module concept	Friend suggestion, recommendation mechanisms, search result ranking, face recognition - what is common? Linear algebra is at their heart. Data are naturally stored in matrices, and linear algebra is the science of processing them and understanding and visualizing the structures they constitute. A solid foundation of linear algebra will help you to understand any algorithm operating with matrices, such as principal component analysis (PCA), support vector machines (SVM), neural networks (NN) or latent semantic analysis (LSA). In this course, you will learn the basic theory of linear algebra and see its working in data science using Python. Linear Algebra 1 covers the basic notions of vectors and matrices, Linear Algebra 2 the more advanced topics of linear mappings and matrix decompositions such as SVD.
Module type	Required Module
Form	Regular Course (weekly)
ECTS credits	3 ECTS Credits
Teaching language	English
Head	Peter Scheiblechner
Adjunct lecturers	Peter Büchel

Module positioning	
Admission requirements	None
Recommended semester	1st Semester
Remarks	None

Module objectives	
Overall objective	Students understand the algebra and geometry of vectors, matrices, linear maps, and linear equation systems, and are able to operate with them manually and with a computer.
Objective: **Professional skills**	Students - are proficient in the algebra and geometry of vectors - are proficient in matrix algebra incl. inversion and determinants - are able to set up and solve a linear system of equations
Objective: **Problem-solving and critical thinking**	Students - understand how information can be represented and processed using matrices

	- are able to recognize, understand, and visualize linear structures in high dimensional spaces
Objective: **Method skills**	Students - are able to handle abstract notions and apply them to concrete situations. - are able to apply linear algebra methods using the language Python.
Objective: **Communication skills**	Students are able to describe the ideas of data representations and algorithms appropriately and to communicate their results effectively.
Objective: **Interpersonal skills**	Students - are able to work collaboratively in teams - are open to and able to offer constructive criticism

Contents	
Topic 1: **Vector geometry**	Vectors in two and three dimensions
Topic 2: **Linear Equations**	Theory of general linear equation systems, Gaussian elimination
Topic 3: **Matrix algebra**	Matrices and their operations, inverse matrix, determinants

Teaching and learning		
Coursework:	**Hours**	**Hours (%)**
Contact hours	21 hrs	23.3%
Coaching	0	0%
Self-study	69 hrs	76.7%
Other		
Total	**90 hrs**	**100.0%**

Details on teaching and learning methods:

Teaching and learning methods: **Classroom**	Discussion-based lessons with examples Presentation
Teaching and learning methods: **Coaching**	None
Teaching and learning methods: **Self-study**	Exercises

Teaching and learning methods: **Other**	None

Assessments (Adaptions are possible at any time.)		
Assessments	**Assessment 1**	**Assessment 2**
Type of performance record	Online test	Written examination
Evaluation type	Grades	Grades
Scope	Questions concerning the exercises	60 min., plus 30 min. for technical preparation
Date	During the semester (weekly)	During the official examination period (end of semester)
Weighting (if two assessments)	30%	70%
Aids/materials	All	Own summary

Notes on the assessments:

Language	German or English (free of choice)
Certificates	n/a
Attendance	None

Teaching material	
Literature	Any book on linear algebra Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong: Mathematics for Machine Learning
Lecture notes	Yes
Online resources	http://immersivemath.com/ https://www.3blue1brown.com/topics/linear-algebra
Software	Python
Other resources	Slides

Linear Algebra 2

Module description	
Module code	W.MSCIDS_LIA02.22
Module name	Linear Algebra 2
Most recent change	May 2023
Module concept	Friend suggestion, recommendation mechanisms, search result ranking, face recognition - what is common? Linear algebra is at their heart. Data are naturally stored in matrices, and linear algebra is the science of processing them and understanding and visualizing the structures they constitute. A solid foundation of linear algebra will help you to understand any algorithm operating with matrices, such as principal component analysis (PCA), support vector machines (SVM), neural networks (NN) or latent semantic analysis (LSA). In this course, you will learn more theory of linear algebra and see its working in data science using Python. Linear Algebra 2 covers the more advanced topics of linear mappings and matrix decompositions such as SVD.
Module type	General Core Elective Module
Form	Regular Course (weekly)
ECTS credits	3 ECTS Credits
Teaching language	English
Head	Peter Scheiblechner
Adjunct lecturers	Peter Büchel

Module positioning	
Admission requirements	Linear Algebra 1 (W.MSCIDS_LIA01)
Recommended semester	3rd Semester
Remarks	None

Module objectives	
Overall objective	Students understand the algebra and geometry of vectors, matrices, linear maps, and linear equation systems, and are able to operate with them manually and with a computer.
Objective: **Professional skills**	Students - are familiar with the concepts of vector subspaces, basis, dimension, and their applications to linear maps and matrices - understand the geometry of inner products and orthonormality - are able to perform eigenvalue and singular value decomposition
Objective: **Problem-solving and critical thinking**	Students - understand how information can be represented and processed using matrices

	- are able to recognize, understand, and visualize linear structures in high dimensional spaces
Objective: **Method skills**	Students - are able to handle abstract notions and apply them to concrete situations. - are able to apply linear algebra methods using the language Python.
Objective: **Communication skills**	Students are able to describe the ideas of data representations and algorithms appropriately and to communicate their results effectively.
Objective: **Interpersonal skills**	Students - are able to work collaboratively in teams - are open to and able to offer constructive criticism

Contents	
Topic 1: **Euclidean vector space**	Subspace, span, linear independence, basis, dimension, coordinates, scalar products, norms, orthonormality
Topic 2: **Linear maps**	Basics, Matrix of a linear map
Topic 3: **Matrix decompositions**	Eigenvalues and -vectors, diagonalization, singular value decomposition

Teaching and learning		
Coursework:	**Hours**	**Hours (%)**
Contact hours	21 hrs	23.3%
Coaching	0	0%
Self-study	69 hrs	76.7%
Other		
Total	**90 hrs**	**100.0%**

Details on teaching and learning methods:

Teaching and learning methods: **Classroom**	Discussion-based lessons with examples Presentation
Teaching and learning methods: **Coaching**	None
Teaching and learning methods: **Self-study**	Exercises

Teaching and learning methods: **Other**	None

Assessments (Adaptions are possible at any time.)		
Assessments	**Assessment 1**	**Assessment 2**
Type of performance record	Online test	Written examination
Evaluation type	Grades	Grades
Scope	Questions concerning the exercises	60 min., plus 30 min. for technical preparation
Date	During the semester (weekly)	During the official examination period
Weighting (if two assessments)	30%	70%
Aids/materials	All	Own summary

Notes on the assessments:

Language	German or English (free of choice)
Certificates	n/a
Attendance	None

Teaching material	
Literature	Any book on linear algebra Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong: Mathematics for Machine Learning
Lecture notes	Yes
Online resources	http://immersivemath.com/ https://www.3blue1brown.com/topics/linear-algebra
Software	Python
Other resources	Slides

Management of Digital Enterprise

Module description	
Module code	W.MSCIDS_MDE02.18
Module name	Management of Digital Enterprise
Most recent change	June 2023
Module concept	Technology knowhow has become a core competence of companies, disrupting the way business is done but it can only develop its potential in interaction with business management. This module comes into play at the **interface** between **technology** and **business administration**. Students learn about models, procedures, methods and tools that enable companies to transform their product-oriented business model into a **digital, data-driven business model**. The module imparts practice-relevant knowledge about intelligent sensors, wireless communication systems for the transport of data, methods of data analysis and artificial intelligence, data-driven services as well as most recent knowhow about quantum computing and of course business models. Further subject areas are the Tomorrow's mobility, the Internet of Things, 3-D printing, robotics, industry 4.0, and the management of supply structures. During the modul various speakers from finance, retail and technology consulting side will join for short input sessions about their impact digital tech has on their daily business. **You will see, it going digital and developing a digital strategy is no rocket science: it'll be fun!**
Module type	General Core Elective Module
Form	Regular Course (weekly), second half of semester
ECTS credits	3 ECTS Credits
Teaching language	English
Head	Andreas Lucco
Adjunct lecturers	Experts from various practice partners

Module positioning	
Admission requirements	None
Recommended semester	2nd semester

Contents	
Topics:	– Megatrend Digitalisation – Enabling Technologies – Big data, neuronal networks, Artificial Intelligence – Virtual and augmented reality – Robotics – Drones – Blockchain and Cryptovalues – 3-D Printing

	– Internet of Things (IoT) – From Transistors to Quantum computing – Individualization, Intermediation and Sharing – Socialisation – Automation – Mobilisation and Democratisation – Disruptive Forces, Industry Disruption – Business Model Innovation – Digital Business Models – Digital Strategies – Digital Maturity Models – Digital Use Cases – Digital Strategy (8 Steps) – Impact on Employment – AI and Ethics – Cyber Crime and Security

Teaching and learning

Coursework:	**Hours**	**Hours (%)**
Contact hours	18 hrs	20.0%
Coaching	35 hrs	38.9%
Self-study	37 hrs	41.1%
Total	90 hrs	100.0%

Assessments

(Adaptions are possible at any time)

Assessments	**1**	**2**	**3**	**4**
Type of performance record	Powerpint presentation (live)	Powerpint presentation (live)	Powerpint presentation (recorded)	Powerpint presentation (recorded)
Evaluation type	Grade	Grade	Grade	Grade
Scope	Technology Persentation	Trends Persentation	Case Study	Case Study
Date	Published on ILIAS	During the semester - according to the lecturer's information		
Weighting	30%	20%	25%	25%
Aids/materials	Your brain and curious mind, research results online, videos online and on ILIAS Open Book			

Notes on the assessments:

Language	English
Certificates	n/a
Attendance	80% attendance requirement

Teaching materials

Literature	– Beckenbauer, Angela, Kobe, Carmen uva.: Changes in revenue models resulting from digital product-service systems using the example of dormakaba. In: Uhl, Axel, Loretan, Stefan (Hrsg.) a.a.O. – Diallo, A., MacGillavry, K. and Uhl, A.: Digital Transformation at DHL Freight. The Case of a Global Logistics Provider, in 360° – The Business Transformation Journal, Innovation Special Issue No. 9, 2014, pp. 74–85. – Domma, Peter, Ochs, Thomas, Uhl, Axel: Strategic analysis and organizational solutions for the digital transformation of a medium-sized company. In: Uhl, Axel; Loretan, Stefan (Hrsg). a.a.O. – Gollenia, Lars, Uhl, Axel, Giovanoli, Claudio: Next generation IT strategy: In: Business Transformation journal, 2014 – Uhl, A., Loretan, H. (Hrsg.): Digitale Geschäftsmodelle für den Mittelstand. So schaffen Sie den Weg in die Zukunft., The importance of digital transformation for Swiss SME`s. Springer-Vieweg, 2019 – Uhl, Axel, Heinrich, Peter, Günthner, Ralf: IoT-based business models for Swiss SMEs – concepts for the digital future. In: Uhl, Axel, Loretan, Stefan (Hrsg): a.a.o. – Additional sources/articles – Uhl, Axel, Lars Alexander Gollenia (Hrsg.): Digital Enterprise Transformation. A business driven approach to leverage innovative IT. Gower Publishing, 2014. – Béchet, M., Lütke Siestrup, T., Uhl A., and Hulshof H-J.: Unilever Case Study: Implementing the Real-Time, Digital Enterprise to Unlock Value and Enable Business Growth, 360° – The Business Transformation Journal, No. 11, 2014, pp. 66–79. – Uhl, Axel and Mahnken, Daniel: The logistics marketplace Saloodo! digitalizes the transport industry. In: Uhl, Axel, Loretan, Stephan (Hrsg.) a.a.O. – Uhl, A., Schmid, A. and Zimmermann, R.: From the Concert Hall to the Web. How the Berliner Philharmoniker Transformed Their Business Model, in 360° – The Business Transformation Journal, No. 8, 2013, pp. 46–55. – Vom Brocke, J., Debortoli, S., Müller, O. and Uhl, A.: Driving Retail Innovation. The Demand for Digital Capabilities to Transform the Industry, in 360° – The Business Transformation Journal, Innovation Special Issue No. 9, 2014, pp. 44–53. – – vom Brocke, J., Debortoli, S., Müller, O. and Uhl, A.: In-Memory Database Business Value. Results from a Study on Retail Innovation, in 360° – The Business Transformation Journal, No. 7, 2013, pp. 16–26.
Lecture notes	Slide Set
Online resources	e-Learning modules on ILIAS

Modern Data Engineering

Module description	
Module code	W.MSCIDS_ETL03.20
Module name	Modern Data Engineering
Most recent change	June 2022
Module concept	The students receive an in-depth introduction to data engineering processes, as they are frequently used in industry today and which are important for data scientists, since the preparation of data is still a major part of a data scientist's work. The module gives an overview of the current trends in Data Engineering as well as over-arching data architectures, implemented with modern storage technologies, like NoSQL DB's, object storage and cloud solutions. In a first part a general overview is given. Then there is a Lab which consist of implementing an ELT-Proccess with the tool Apache HOP as well as a realtime stream process using Apache Kafka. Everything takes place on an Azure Cloud environment.
Module type	Core Elective Module – Advanced Analytics and Engineering
Form	Regular Course (weekly)
ECTS credits	3 ECTS Credits
Teaching language	English
Head	Christian Dollfus
Adjunct lecturers	Pavlin Mavrodiev Tim Giger

Module positioning	
Admission requirements	- Database Management for Data Scientists (W.MSCIDS_DBM02.18) - Data Collection Integration and Preprocessing (W.MSCIDS_CIP02.18) - Recommended: Data Warehousing and Data Lakes (W.MSCIDS_DWL03.21)
Recommended semester	3rd semester
Remarks	

Module objectives	
Overall objective	Students learn how to independently implement full automatic Data Engineering Streams/Pipelines with a state-of-the-art tool as well as an overview on Big Data concepts and how to use Cloud Computing

Objective: **Professional skills**	Students are able to have a practical knowledge of all major parts of modern Data Engineering: from the Cloud, to Data Lake and Big Data Infrastructure as well as traditional and mixed architectures used today in the industry. They have a technical knowledge to build data pipelines on their own and have an overview of all the relevant elements.
Objective: **Problem-solving and critical thinking**	Students are able to put known requirements and tasks in Data Engineering into practice. They can advise both sides, IT and business during the conception phase and implementation with the needed knowledge in Data Engineering. Today this is one of the most needed knowledge in the industry
Objective: **Method skills**	Students are able to enlarge the knowledge of data collecting, reading, storing, shaping, harmonizing and preparing for further machine learning in a modern way. They can implement data quality issues in data pipelines. Further, a realtime data process is implemented in practice.
Objective: **Communication skills**	Students are able to formulate potential problems and requirements within industry projects to the different stakeholders
Objective: **Interpersonal skills**	Students can bridge the gap between the business representatives in companies and IT/DWH specialists. They are able to understand both sides concerning the management and engineering of the data to prepare for further analysis or systems.
Objective: **Personal skills**	No explicit ones

Contents	
Topic 1: Introduction and Motivation	*In this part we intend to get an overall overview of the elements of Data Engineering and some historical background* • What is Data Engineering? • Motivation and Value Proposition, Historic Overview • How does Data Architectures are Built in a reference architecture • How does Data Architectures look like in many companies? • What are features and advantages of workflow-based ETL? • Motivation for the use of ETL tools. Data Engineering and Business Process Automation - similarities/differences • Realtime Streaming and concepts • Object Storage and NoSQL Databases as well as realtime streaming architectures (Data Lakes as well as combination of batch- and realtime processing)
Topic 2: Foundations and Storage Technologies of Data Engineering: Big Data Principles, DataLakes and Cloud Computing	*This part will introduce the storage technologies based on so called "NoSQL" technologies and give an overview of cloud computing and common cloud providers* 1. Short History of Data and databases 2. Intro to Big Data and Big Data Engineering 3. Fundamental concepts • Concept of Data Lake and Data Storage techniques: • OnPremise vs. Cloud (also OnPremise Cloud) and everything in between • Overview of Cloud Solutions/Vendors Examples like Netflix

Topic 3: Introduction into ELT: Overview of data processes – Pipelines and Workflows	*This is the entry part in the world of the construction of data pipelines using a standard ETL-Tool* • Workflows and Pipelines in Apache HOP • Building hierarchical Robot-Architectures • File Handling, Data Preparation Utilities, Webservice-Connectors, Connection Harvesting, ... • DB read/write, Lookups (stream, DB), Joins, Sort, String handling, Filtering (fields/records), types and much more • This Topic is more a practical LAB, giving some guidance and overview slides for the usage of the Tools.
Topic 4: Integration of Real time Streaming and Data Science Tools: Real time ELT Architectures	*In this part we look for the implementation of Data Science algorithms into data pipelines and perform real time architectures* • Different architecture principles, Lamdba- and Kappa-Architectures, Kafka, pros and cons. of the different solutions • Using Plugins like Kafka Connector, Python Script executer in Apache HOP (using Apache Maven to install)
Topic 5: Integration of ELT into production and an overview to bild more complicated and larger solutions	*In a productive environment, software development tools are used also for data engineering solutions* • Scheduling Apache HOP Pipelines and Workflows • Using GIT for Version control • Remote running of workflows • Properties, Variables and Metadata Injection • Handle unreliable input data : possible solutions with status tables and polling techniques
Topic 6: Enhancement of the overall Process – Data Scraping, Robotic Process Automation. Trends and the Future	*The last part focuses on additive important tasks in Data Engineering and especially data sourcing, there is a link to new RPA-tools becoming more and more important in industry* • Additive features important for Data Engineering i.e. Web Scraping, PDF reading, ... Using the tools in conjunction • Data Engineering and Business Process Automation – Similarities/differences. • What are future ideas of Data Engineering - Research at HSLU in the field of Data Engineering

Teaching and learning

Coursework:	**Hours**	**Hours (%)**
Contact hours	40 hrs	44
Coaching	20 hrs	22
Self-study	20 hrs	22
Other	10 hrs	12
Total	**90 hrs**	**100**

Details on teaching and learning methods:

Teaching and learning methods: **Classroom**	The learning contents will be taught and distributed over the class. During the on-class study students are expected to develop by themselves implementing data pipelines on the cloud.
Teaching and learning methods: **Coaching**	During the lessons we leave room for practical implementation as this topic is more an engineering one that needs not much theoretical knowledge. The aim is to begin with the final task and develop an integrated data engineering solution in the cloud.
Teaching and learning methods: **Self-study**	Independent development on the cloud is possible on an individual basis
Teaching and learning methods: **Other**	The final task can be engineered in teams of 2 (max 3) persons.

Assessments

(Adaptions are possible at any time.)

Assessments	**Assessment 1**	**Assessment 2**
Type of assessment	Final project (task) in ELT using Apache HOP	Final project (task) in realtime streaming using Apache KAFKA
Evaluation type	Grades (fail/pass)	Grades (fail/pass)
Scope	15 hrs	15 hrs
Dates	Uploading the exam 3 weeks after the course beginning	Uploading the exam 3 weeks after the course beginning
Weighting (if two assessments)	100%	
Aids/materials	No restriction, except that it is a work of its own	No restriction, except that it is a work of its own

Notes on the assessments:

Language	English
Certificates	N.A.
Attendance	Attendance is expected since the module is carried out compactly in one block week. Everyone builds their own data pipelines step by step under guidance as well as a full realtime datastream unsing the Apache Tools HOP and KAFKA.

Teaching materials

Literature	
Lecture notes	Scripts will be provided to students on the class / website.
Online resources	https://hop.apache.org/manual/latest/ https://www.coursera.org/ https://www.udemy.com

	https://www.udacity.com/ https://www.datacamp.com https://towardsdatascience.com/ https://www.youtube.com
Software	Apache HOP, Apache KAFKA Azure Cloud
Other resources	Scientific and technological reading material will be recommended to students during the lecture. Other very good resources: https://towardsdatascience.com/ https://data-science-blog.com/blog

Natural Experiments Using R

Module description	
Module code	W.MSCIDS_DE_NER01.21
Module name	Natural Experiments Using R
Most recent change	July 2021
Module concept	The aim of this course is to understand, interpret, and evaluate natural experiments using R. Natural experiments have become an important tool to estimate causal effects in business, economics, political science, and sociology. Scholars have used natural experiments to analyze questions ranging from the impact of Yelp ratings on restaurant revenues, the effect of education on wages, and the relationship between anti-smoking laws and cigarette consumption. Each session first introduces a research design for natural experiments. In a second part, students will apply their knowledge in R tutorials. In the third part, students will work on a project with the goal of understanding and critizing a current research article.
Module type	Core Elective Module – Domain Experience
Form	Block Seminar on site (autmn semester: Feb. / spring semester: Aug./Sept.)
ECTS credits	3 ECTS Credits
Teaching language	English
Head	Lukas Schmid
Adjunct lecturers	None

Module positioning	
Admission requirements	R-Bootcamp (W.MSCIDS_RB01.19)
Recommended semester	none
Remarks	none

Module objectives	
Overall objective	– Students can understand, interpret, and evaluate natural experiments.

	– They will learn how to model, analyze and visualize natural experiments.
Objective: **Professional skills**	– Understand the most important empirical designs that use natural experiments. – Understand the differences and similarities between experiments and natural experiments. – Find studies on natural experiments.
Objective: **Problem-solving and critical thinking**	– Students are able to critically assess natural experiments. – They should also be able to identify the strengths and weaknesses of their own work.
Objective: **Method skills**	– Students are able to estimate empirical models on natural experiments. – Students can perform robustness tests.
Objective: **Communication skills**	– Students are able to present their work convincingly. – They are able to communicate the purpose, approaches and main results of their work, as well as the conclusions they have drawn.
Objective: **Interpersonal skills**	– Students should be self-critical about their work and accurately identify its weaknesses.

Contents	
Topic 1: **Experiments and Natural Experiments**	– Explain the caveats of ordinary least squares regression. – Explain the selection problem. – Explain the advantages of natural experiments – Know the difference between experiments and natural experiments.
Topic 2: **Matching**	– Describe the key assumption of the machting. – Estimate a matching model. – Interpret an matching estimate – Criticize the assumptions of matching.
Topic 3: **Instrumental Variables**	– Describe the key assumption of the instrumental variable design. – Estimate an instrumental variable design model. – Interpret an instrumental variable regression – Criticize the assumptions of an instrumental variable design.
Topic 4: **Difference-in-Differences**	– Describe the key assumption of the difference-in-differences design. – Estimate a difference-in-differences model. – Interpret a difference-in-differences regression – Criticize the assumptions of an difference-in-differences design.
Topic 5: **Regression Discontinuity Design**	– Describe the key assumption of the regression discontinuity design. – Estimate a regression discontinuity model. – Interpret an difference-in-differences regression – Criticize the assumptions of an regression discontinuity design.

Teaching and learning		
Coursework:	**Hours**	**Hours (%)**
Contact hours	30 hrs	33.3%
Coaching	30 hrs	33.3%
Self-study	30 hrs	33.3%
Other		
Total	**90 hrs**	**100.0%**

Details on teaching and learning methods:

Teaching and learning methods: **Classroom**	Discussion-based lessons
Teaching and learning methods: **Coaching**	Further study and specific applications of the research designs.
Teaching and learning methods: **Self-study**	Reading about the topic.
Teaching and learning methods: **Other**	None

Assessments (Adaptions are possible at any time.)		
Assessments	**Assessment 1**	**Assessment 2**
Type of assessment	Presentation of a project and submission of the presentation in a PDF file; further information will follow.	
Evaluation type	Grade	
Scope	Presentation of own work.	
Dates	During the block seminar - according to the lecturer's information	
Weighting (if two assessments)	100%	
Aids/materials	None	None

Notes on the assessments:

Language	English (Answers in German allowed)
Certificates	None
Attendance	100%

Teaching materials	
Literature	Students will receive the lecture slides with further reading before the course.
Lecture notes	None
Online resources	Based on the lecture slides
Software	R. Other languages (Matlab, Stata, SAS, Python, etc) are allowed, but not supported.
Other resources	None

NoSQL Lab with Python & MongoDB

Module description	
Module code	W.MSCIDS_BDL03_1.22
Module name	NoSQL Lab with Python & MongoDB
Most recent change	September 2021
Module concept	The module is a direct continuation of the preceding modules and consolidates knowledge gained so far about using Python and databases. Participants will complete various lab exercises to learn which use cases can be solved more efficiently with a conventional relational database or with a NoSQL database like MongoDB. Python is generally used as programming language, with some JavaScript exceptions for command line operations.
Module type	Core elective module – Advanced Analytics and Big Data
Form	Regular Course (weekly)
ECTS credits	3 ECTS Credits
Teaching language	English
Head	Oliver Staubli
Adjunct lecturers	

Module positioning	
Admission requirements	Data Collection, Integration and Preprocessing (W.MSCIDS_CIP02.18) Database Management for Data Scientists (W.MSCIDS_DBM02.18)
Recommended semester	3rd Semester
Remarks	The module focuses on data manipulation in databases (SQL DBs and NoSQL DBs) in connection with the Python programming language.

Module objectives	
Overall objective	Students are able to use the Python programming language to access relational databases, insert and extract data for conducting data analysis. Students can experience first hand the differences between relational databases and NoSQL DB in lab exercises. Students will practice what they have learned in a personal project conducting an in-depth data analysis on their own MongoDB cluster in the cloud.

Objective: **Professional skills**	Based on the modules 'Data Collection, Integration and Preprocessing' (CIP) and 'Database Management for Data Scientists', students are able to explain and complete basic CRUD tasks for SQL and NoSQL databases.
Objective: **Problem-solving and critical thinking**	Students are able to analyze lab tasks and decide which use cases can be solved effectively with which approach. They are able to explain their choice (relational / NoSQL / other) and apply their gained knowledge to other projects.
Objective: **Method skills**	Students are able to decide whether to apply relational or NoSQL methods for managing use cases with large data sets. They will solve some cases by using both methods to clearly understand the difference (i.e. learning by doing).
Objective: **Communication skills**	Students are able to ask questions and share their solutions overcoming technical issues while installing the various course software tools. The ILIAS forum is used for FAQ and sharing solutions.
Objective: **Interpersonal skills**	Students are able to collaborate with others in completing various laboratory exercises, whereby they will learn to address possible differences of opinions objectively.
Objective: **Personal skills**	Students are able to come up with ideas for in-depth data analysis and the needed data, therefore fostering their creativity.

Contents	
Topic 1: **Python Database Programming**	• Introduction to SQLite3, MySQL and PostgreSQL in combination with Python • Saving and retrieving data with Python in relational databases • CRUD operations with SQL
Topic 2: **NoSQL**	• What is NoSQL? • NoSQL vs. Big Data? • Difference between SQL and NoSQL
Topic 3: **MongoDB:**	• Introduction to MongoDB • Database Design for Document-Databases • Introduction to MongoDB Atlas (Cloud DBaaS) • Query MongoDB using Python (PyMongo)

Teaching and learning		
Coursework:	**Hours**	**Hours (%)**
Contact hours	30 hrs	33%
Coaching	0 hrs	0%
Self-study	50 hrs	56%
Other	10 hrs	11%
Total	**90 hrs**	**100.0%**

Details on teaching and learning methods:

Teaching and learning methods: **Online**	During the class, selected code examples are created or reviewed. Exercises enable you to deepen the learned content.
Teaching and learning methods: **Coaching**	Hands on exercises on personal device (BYOD – Bring Your Own Device)
Teaching and learning methods: **Self-study**	Students will need to complete some of the lab exercises individually between the lessons to ensure continuity in content the next time the class meets. For selected topics references to literature and videos will be provided.
Teaching and learning methods: **Other**	Assessment 1 consists of an interactive online course (DataCamp course "Introduction to MongoDB in Python")

Assessments

(Adaptions are possible at any time.)

Assessments	**Assessment 1**	**Assessment 2**
Type of assessment	Completing the online course in accordance with the lecturer's instructions	Submission of a personal project applying MongoDB and Python knowledge in an in-depth data analysis
Evaluation type	Grade	Grade
Scope	Homework / self-study (time: 8 hrs.)	Homework / self-study (time: 8 hrs.)
Dates	During the semester - according to the lecturer's information	During the semester - according to the lecturer's information
Weighting (if two assessments)	30%	70%
Aids/materials		Requirements: Personal project must be completed individually and the result is the author's original work.

Notes on the assessments:

Language	English (answers may be given in German)
Certificates	None – but Assessment 1 and 2 must be submitted in the given deadlines
Attendance	80%

Teaching materials

Script	Course website (Wiki) including various examples and exercises

Online resources	Communicated during the classes
Software	Jupyter Notebook, PyCharm, DBeaver, MySQL/MariaDB Server, MongoDB Compass
Other resources	MongoDB Atlas (Cloud DBaaS). Others communicated during the classes

Pattern Recognition in Audio Signals

Module description	
Module code	W.MSCIDS_PRA03.19
Module name	Pattern Recognition in Audio Signals
Most recent change	June 2021
Module concept	We constantly perceive audio signals, either directly or indirectly, and our brain continuously processes sound and feeds us information about our surroundings, for example when we hear street noises. In this module, students learn about the sources of audio data, the format in which it is stored in computers, and how it can be processed. Before audio signals can be analyzed, audio data must generally first be processed with some preliminary steps. Once the data has been converted in a suitable format, it becomes possible to extract its attributes and let an algorithm carry out the tasks we have defined. For example, students learn how to apply machine learning methods when assigning pieces of music to a certain genre, recommending suitable music for a radio station, or recognizing and translating sequences of spoken text. Machine learning can also be used to compose pieces of music in a certain genre, or to create artificial voices for entertainment purposes.
Module type	Core Elective Module – Advanced Analytics and Big Data
Form	Regular Course (weekly)
ECTS credits	3 ECTS Credits
Teaching language	English
Head	Kilian Schuster
Adjunct lecturers	

Module positioning	
Admission requirements	- Applied Machine Learning and Predictive Modelling 1 (W.MSCIDS_MPM02.18) - Data Collection, Integration and Preprocessing (W.MSCIDS_CIP02.18)
Recommended semester	3rd semester
Remarks	None

Module objectives	
Overall objective	Students are able to explain and contrast the main machine learning methods for processing audio data. They are able to explain the underlying algorithms and technologies of these methods, select suitable

	options for a given data set, and explain their choice. Furthermore, they have the necessary practical experience in solving exemplary problem tasks of varying complexity in order to explain the possibilities and limitations of the methods used, and they can apply them to new image data sets. Students are able to deepen their understanding of the underlying technologies independently, follow developments in new research methods, and apply what they have learned.
Objective: **Professional skills**	Students are able to explain the essential attributes and peculiarities of audio signals from different sources (speech, music, nature and environment, technology). They are able to display image data, store them in different formats and process and extract specific attributes from them. They can explain the most important machine learning problems and are familiar with the methods for solving them, such as Bayesian Decision, Clustering, Statistical Learning, Neural Networks, Kernel Methods and Markovian Models. They are able to explain the theoretical principles of these methods in order to justify a suitable use in an applied field.
Objective: **Problem-solving and critical thinking**	Students are able to independently assess whether a simple problem can be solved, select suitable steps and methods for doing so, and apply these steps and methods to the data. Students are able to explain the specific requirements, conditions and limits that apply to the methods used. They are able to summarize the historical development up to the latest state of research of the discipline and can anticipate the appropriate development steps accordingly.
Objective: **Method skills**	Students are familiar with cutting-edge tools and can apply them accurately and efficiently to solve specific problems.
Objective: **Communication skills**	Students are able to present the analysis of audio data correctly, coherently and vividly to expert and lay audiences.
Objective: **Interpersonal skills**	
Objective: **Personal skills**	Students are able to reflect on and evaluate their own knowledge against the current level of expertise on technology.

Contents	
Topic 1	Acoustics - Physical / mathematical description and properties - Generation / Propagation / Perception of sound - Technical systems for recording, storage & processing
Topic 2	Signals - Time domain - Frequency domain - Transformation (Fourier) - Spectrograms

Topic 3	Applications - Synthesis of audio signals - Transformation of audio signals - Analysis of audio signals
Topic 4	Models I - Sequential data - Hidden Markov Model - Viterbi decoder - Learning & adaptation
Topic 5	Models II - Neural Networks - Recurrent Neural Networks - Attention & Transformers - Application to audio signals
Topic 6	Intelligent Virtual Assistants - Language & speech - Linguistics - Historical evolution of methods - State of the art - Outlook

Teaching and learning		
Coursework:	**Hours**	**Hours (%)**
Contact hours	30 hrs	33.3%
Coaching	30 hrs	33.3%
Self-study	30 hrs	33.3%
Other		
Total	**90 hrs**	**100.0%**

Details on teaching and learning methods:

Teaching and learning methods: **Classroom**	Lectures including demonstrations and short exercises that students do individually or in groups. These conclude with a discussion on what has been achieved. The module uses a problem-based learning approach that aims to incrementally build and consolidate the content throughout the course.
Teaching and learning methods: **Coaching**	Weekly written homework to be submitted individually. A written and individual assessment is given on a weekly base. In addition, a review to the previous homework is given to the audience at the beginning of each lesson.
Teaching and learning methods: **Self-study**	Weekly homework.

Teaching and learning methods: **Other**	Students prepare a short speech (presentation) to be held to the audience during the last lecture of the course.

Assessments
(Adaptions are possible at any time.)

Assessments	**Assessment 1**	**Assessment 2**
Type of assessment	Weekly homework, to be solved individually	
Evaluation type	Grades	
Scope		
Dates	During the semester - according to the lecturer's information	
Weighting (if two assessments)	100%	
Aids/materials		

Notes on the assessments:

Language	German or English (free of choice)
Certificates	None
Attendance	None

Teaching materials

Literature	- 'Machine Learning for Audio, Image and Video Analysis', Camastra, Francesco, Vinciarelli, Alessandro - 'Hands-On Machine Learning with Scikit-Learn and TensorFlow', Aurélien Géron - 'Fundamentals of Music Processing', Müller Meinhard
Lecture notes	Will be posted to Ilias.
Online resources	
Software	- https://www.tensorflow.org/ - https://keras.io - http://scikit-learn.org

Python for Data Science

Module description	
Module code	W.MSCIDS_PDS01.18
Module designation	Python for Data Science
Most recent change	October 2021
Module concept	Students learn the Python programming language independently with the help of a special e-learning course (intermediate user-level). Classes provide students with opportunities for learning independently but also for doing additional exercises as needed. Advanced learners and beginners can benefit in accordance with their level.
Module type	Required module
Form	Regular Course (weekly)
ECTS credits	6 ECTS Credits
Teaching language	German / English
Head	Erwin Mathis (german)
Adjunct lecturers	Simon Broda / Ramón Christen (english)

Module positioning	
Admission requirements	None
Recommended semester	1st semester
Remarks	For this introductory module, the entry requirements for learning a programming language allow students with different backgrounds to participate. Students will get a solid and documented background in programming and be able to apply, reflect on, and communicate their knowledge.

Module objectives	
Overall objective	Students learn a new programming language independently. By end of this course, they will be able to tackle programming tasks of medium difficulty with Python and are thus prepared for following modules in the master program involving Python as tool kit. Additionally, the handling of Linux and cloud services is also trained.
Objective: **Professional skills**	Students are able to work with structured and unstructured data and can understand and solve problems relating to data science effectively on their own.
Objective: **Problem-solving and critical thinking**	Students are able to evaluate the possibilities and limitations of a programming language and can decide which technique to use for solving a specific problem.
Objective: **Method skills**	Students learn to analyze programmable tasks and to complete them with the programming language Python.
Objective: **Communication skills**	Students are able to communicate with colleagues from various disciplines on a common language and obtain or provide the necessary support, e.g. via a suitable internet forum.
Objective: **Interpersonal skills**	Students contribute to classes from their own experience.
Objective: **Personal skills**	Students learn to recognize and evaluate their own learning and/or timing issues.

Contents	
Topic 1: **Understanding and applying the basics of Python**	• Numbers, variables • The use of 'strings' • Lists in Python • Casting of data types • Applying controls in Python correctly • Selection: if, else • Iteration: while, for • The use of operators • Introduction to various Python development environments
Topic 2: **Advanced principles**	• Functions • Reading and writing files • Examining lists, e.g. slicing • Dictionaries, Tuple, Set • List comprehensions vs. lambda functions • Object orientation with Python • Class and objects and their implementation in practice • Inheritance

Topic 3: **Understanding and working with modules**	• Working with modules • Exception handling in Python: clarifying the basic principles • Students understand and can apply the following technical terms in literature and their own Python programs: iterators, generator

Teaching and learning methods		
Coursework:	**Hours**	**Hours (%)**
Classroom or online	60 hrs	
Coaching		
Self-study	60 hrs	33.3%
Other	60 hrs	33.3%
Total	**180 hrs**	**100.0%**

Details on teaching and learning:

Teaching and learning: **Classroom or Online**	This basic module enables students to complete e-learning units in advance. During the class, selected code examples are created or reviewed. Exercises allow students to understand thoroughly the content they have learned and to identify any ambiguities they may have. In special situations (e.g. Corona) the teaching style may be different.
Teaching and learning: **Coaching**	In the existing 'Python forum', the students and the lecturer support other students in a "low-noise" way.
Teaching and learning: **Self-study**	The content of the second half of the lecture deliberately prepares students for various subsequent modules in which they use Python as programming language. Further exercises enable students to understand practical examples themselves.
Teaching and learning: **Other**	This Python module also provides in-depth references to literature and videos on selected topics.

Assessments (Adaptions are possible at any time.)		
Assessments:	**Assessment 1**	**Assessment 2**
Type of assessment	Written examination on your own notebook and a virtual Linux machine.	None
Evaluation type	Grades	None
Scope	90 minutes	None
Date	During the official examination period	None
Weighting (if two assessments)	100 %	None
Aids/materials	Your own books and notes and all online resources. No communication with bots, persons, ai-machines etc.	None

Additional notes on the assessments:

Language	English (Answers in German allowed)
Certificates	None
Attendance	80%

Literature	
Script	None - but various exercises!
Online resources	• https://www.python.org/ • Python Bootcamp: https://www.udemy.com/course/the-complete-python-masterclass • Python course https://www.python-course.eu/python3_course.php
Software	Jupyter Notebook, PyCharm
Other resources	Communicated in lectures.
Literature	Communicated in lectures.

R-Bootcamp

Module description	
Module code	W.MSCIDS_RB01.19
Module name	R-Bootcamp
Most recent change	January 2023
Module concept	**R** is THE statistical software. It is open source and free, is constantly developed by the **R**-core Team and via add-on packages written by thousands of contributors. Along with Python **R** represents the most widely used tool for data analysis in Data Science. Often tools such as **R** are learned "on the way" with no formal introduction to it. This leads to a knowledge gap in the usage of the software. This course, along with the companion course "a modern introduction to R for data scientists", tries to fill this gap by providing students with a solid and complete introduction into **R** and its modern use in data science. This course guides you hands-on through the important steps of a data analysis and proposes ways how to deliver your results.
Module type	General core elective module
Form	Block Seminar autumn semester: Feb. --> online spring semester: Sept. --> on site
ECTS credits	3 ECTS Credits
Teaching language	English
Head	Claude Renaux
Adjunct lecturers	Matteo Tanadini

Module positioning	
Admission requirements	**Online self-learning course: A modern introduction to R for data scientists** **Please find it's description below.**
Recommended semester	1st Semester
Remarks	Attending the course "a modern introduction to R for data scientists" is absolutely mandatory. No execptions can be made. Presence on all four days is absolutely mandatory. Students not being able to attend the course in full, must re-enroll the missed part to get the credits.

Module objectives	
Overall objective	Students will learn how to use R and related softwares to carry out a data science project from A to Z.
Objective: **Professional skills**	Not relevant
Objective: **Problem-solving and critical thinking**	Not relevant
Objective: **Method skills**	Not relevant
Objective: **Communication skills**	Not relevant
Objective: **Interpersonal skills**	Not relevant

Contents	
Topic 1: **Reading data into R**	- From spreadsheet - From databases
Topic 2: **Data preparation and data manipulation**	- Taking care of objects class - Creating new variables - Dealing with missing values - Joining datasets from multiple sources - Reshaping datasets
Topic 3: **Graphical analyses**	- Displaying data - Tailoring of graphs (focus on {ggplot2})
Topic 4: **Dynamic reporting**	- Rmarkdown - Knitr - Quarto
Topic 5: **R packages and beyond**	- Better understand peculiarities of add-on packages - Set up unit tests - Built an API - Parallel Computing
Topic 6: **Shiny Apps**	- Introduce Shiny Apps - Write your own Shiny App

Topic 7: **Other and optional topics**	- Creating interactive and static maps - Write your own functions - Control structures (eg. for loops and apply functions) - Write your own package - Create a database

Teaching and learning

Coursework:	**Hours**	**Hours (%)**
Contact hours	30 hrs	33.3%
Coaching	30 hrs	33.3%
Self-study	30 hrs	33.3%
Other		
Total	**90 hrs**	**100.0%**

Details on teaching and learning methods:

Teaching and learning methods: **Classroom**	Exchange-oriented teaching
Teaching and learning methods: **Coaching**	Exchange-oriented teaching
Teaching and learning methods: **Self-study**	Exchange-oriented teaching
Teaching and learning methods: **Other**	none

Assessments

(Adaptions are possible at any time.)

Assessments	**Assessment 1**	**Assessment 2**
Type of assessment	Creation of a dynamic document with a simple analysis	None
Evaluation type	graded	
Scope	Assess learning	

Dates	During the block seminar - according to the lecturer's information	
Weighting (if two assessments)	100%	
Aids/materials	*everything* students may want to use	

Notes on the assessments:

Language	German or English (free of choice)
Certificates	No
Attendance	Yes

Teaching materials	
Literature	None
Lecture notes	None
Online resources	None
Software	R and an editor (eg. Rstudio)
Other resources	None

A modern introduction to R for data scientists

Description	
Form	Online self-learning course
Head	Matteo Tanadini

Module positioning	
Recommended semester	1st Semester
Remarks	This course provides a "formal" introduction to R. It is therefore important to watch all videos and not just pick a couple of them. This holds true also for students who already had an exposure to R and who feel not being beginners. This course is a strong requirement for the "R-Bootcamp" course.

Module objectives	
Overall objective	Students will learn the basics of the statistical software **R.** Students will also be introduced to the use of the editor RStudio.

Contents	
Topic 1: **Basic objects**	- Vectors, matrices, data frames and lists - Functions and function calls
Topic 2: **Simple computations**	- Simple arithmetic - Simple statistics
Topic 3: **R packages**	- Introducing packages
Topic 4: **Importing and preparing data**	- Importing data into R - Checking and preparing data
Topic 5: **Basic Graphs**	- Low level plotting functions - High level plotting function - Interactive plotting functions - Device control
Topic 6: **Manipulating dataset**	- Reshaping datasets - Joining datasets
Topic 7: **Missing values**	- Missing values
Topic 8: **Fitting models**	- Fitting statistical models
Topic 9: **Methods functions**	- Introductions generic and methods functions
Topic 10: **Documenting analyses**	- Introducing Rmarkdown

Teaching and learning		
Coursework:	**Hours**	**Hours (%)**
Contact hours	0 hrs	0%
Coaching	12 hrs	25%
Self-study	36 hrs	75%
Total	**48 hrs**	**100.0%**

Details on teaching and learning methods:

Teaching and learning methods: **Classroom**	Students watch pre-recorded videos. There are 6 lessons (1.5 hours each). Each lesson also contain exercises (with solutions).
Teaching and learning methods: **Coaching**	Students can benefit from a weekly "office hour" and have access to a dedicated forum on ILIAS.
Teaching and learning methods: **Self-study**	Students can work in pairs while watching videos and solving the exercises.

Assessments (Adaptions are possible at any time.)	
Type of assessment	None

Teaching materials	
Software	R and an editor (eg. Rstudio)

Recommender Systems

Module description	
Module code	W.MSCIDS_REC03.20
Module name	Recommender Systems
Most recent change	June 2022
Module concept	Recommender systems are widely used in the business world, for example in the field of marketing. It is therefore important that students have a good grasp of the corresponding technologies and their applications. In this module, students will gain theoretical knowledge and practical experience about building modern recommender systems. They will write Python code to implement what they have learnt from the classroom on an algorithmic and project level. They will also have the opportunity to interact with data scientists working in industry who have extensive relevant experience. The concrete examples of building recommendation systems given in this module will better prepare students for their future roles as data scientists in industry. This module is also an ideal continuation and deepening of previous modules on topics such as machine learning and deep learning.
Module type	Core Elective Modules – Advanced Analytics and Engineering
Form	Block Seminar on site (autumn semester: February / spring semester: Aug.or Sept.)
ECTS credits	3 ECTS Credits
Teaching language	English
Head	Dr. Guang Lu
Adjunct lecturers	N.A.

Module positioning	
Admission requirements	- Applied Machine Learning and Predictive Modelling 1 (W.MSCIDS_MPM02.18) - Data Collection, Integration and Preprocessing (W.MSCIDS_CIP02.18)
Recommended semester	3rd semester
Remarks	The module is delivered in one full week. Through the course, students must be able to understand the key principles behind recommender systems commonly found in commercial applications. This understanding must be gained alongside practical coding practice.

Module objectives	
Overall objective	Students learn how to implement recommendation systems independently in Python. They also learn about classic applications of recommender systems in business.

Objective: **Professional skills**	Students will be able to understand the fundamentals of recommendation systems used by businesses, such as Bayesian-based methods, user-based and item-based collaborative filtering, matrix factorization, restricted Boltzmann machines and other model-based collaborative filtering methods, and knowledge graph-based recommendations.
Objective: **Problem-solving and critical thinking**	Students are able to put theory into practice by implementing a recommendation system in Python. They are able to train, tune and evaluate the performance of the algorithms.
Objective: **Method skills**	Students are able to deepen their previous knowledge and gain new experience in Python programming and machine/deep learning.
Objective: **Communication skills**	Students are able to clearly explain their investigations and findings throughout the block week.
Objective: **Interpersonal skills**	Students will be able to work in teams to complete the final project. The recommended team size is 2-3 students.
Objective: **Personal skills**	Students are able to meet face-to-face with industry experts on what they have learnt from the classroom. They should also expand their industry network in the field of data science.

Contents	
Topic 1:	Fundamentals of recommender systems • Introduction to recommender systems and their applications • Recommender system evaluation methods • Modern frameworks of recommender systems • Rule-based recommender systems • Markov models and PageRank • Recommender systems using Bayesian approach
Topic 2:	Content-based recommender systems • Data mining methods for recommender systems • Theory of content-based recommender systems • Coding exercise, model training and algorithm tuning
Topic 3:	Collaborative filtering for recommender systems • Theory of user-based and item-based recommender systems • Coding exercise building user-based and item-based recommender systems • Model training and tuning the performance of the algorithms
Topic 4:	Matrix Factorization for collaborative filtering • Theory of Matrix Factorization and their application in collaborative filtering • Coding exercise building recommender systems based on Matrix Factorization • Model training and tuning the performance of the algorithms • Probabilistic Matrix Factorization, Factorization Machines and more
Topic 5:	Restricted Boltzmann Machines for collaborative filtering • Theory of Restricted Boltzmann Machines and their application in collaborative filtering

	• Coding exercise building recommender systems based on Restricted Boltzmann Machines • Model training and tuning the performance of the algorithms • Deep learning and auto-encoders for recommendation
Topic 6:	Knowledge graph-based recommender systems • Fundamentals of knowledge graphs • Knowledge Graph Convolutional Networks (KGCN) for Recommender Systems • Other state-of-the-art knowledge graph-based recommendation technologies • Case study – Knowledge graph-based travel recommendations
Topic 7:	Real-world challenges in building recommender systems • Context-aware and hybrid recommender systems, TensorFlow Recommenders (TFRS) • Issues and challenges with real-world recommender systems • Students work in groups on case studies • Case studies provided by data scientists working in industry • Final project – Build your own recommendation system using real-world data derived from commercial applications

Teaching and learning		
Coursework:	**Hours**	**Hours (%)**
Contact hours	30 hrs	33
Coaching	20 hrs	22
Self-study	10 hrs	11
Other	30 hrs	34
Total	**90 hrs**	**100**

Details on teaching and learning methods:

Teaching and learning methods: **Classroom**	The learning content will be taught and distributed in class. During the in-class learning period, students will be expected to set up their own architecture for implementing the recommendation system.
Teaching and learning methods: **Coaching**	The necessary documents and study materials will be published by the lecturer in good time. These materials will also include a literature survey following the first 4 days of study, which is expected to be completed by groups of students.
Teaching and learning methods: **Self-study**	Independent repetition and deepening of important themes. Learning resources will be recommended to students as a reference for that block week and for future learning.
Teaching and learning methods: **Other**	Students will work in teams of 2-3 to solve a final project about building a real-world recommendation system. They will report their investigations and findings in the form of a scientific report.

Assessments (Adaptions are possible at any time.)		
Assessments	**Assessment 1**	**Assessment 2**
Type of assessment	Final project	
Evaluation type	Grades	
Scope	30 hrs	
Dates	During the block seminar - according to the lecturer's information	
Weighting (if two assessments)	100%	
Aids/materials	No restriction, except that it is a work of its own	

Notes on the assessments:

Language	German or English (free of choice)
Certificates	N.A.
Attendance	Attendance is expected as the module is delivered in one full week in a tight schedule. Students are guided step by step to build their own recommendation system.

Teaching materials	
Literature	Datacamp course: • Building Recommendation Engines in Python • Building Recommendation Engines with PySpark Further literature will be systematically recommended in the course of the teaching.
Lecture notes	Scripts will be made available to students in the class/website.
Online resources	https://www.coursera.org/ https://www.udemy.com https://www.udacity.com/ https://www.datacamp.com https://towardsdatascience.com/ https://www.kaggle.com/
Software	Anaconda, Google Colab
Other resources	Relevant reading material will be recommended to students.

SAS Joint Certificate "SAS Business Analytics Expert"

Module description	
Module code	W.MSCIDS_SAS02.22
Module name	SAS Business Analytics Expert
Most recent change	August 2022
Module concept	The SAS Specialization "**SAS Business Analytics Expert**" is a Joint Certification of HSLU and SAS. It is part of the SAS Academic Program and listed here: https://www.sas.com/content/dam/SAS/documents/technical/education/en/sas-joint-academic-programs.pdf It is a business certification, because it consists of handling data and working on a project, the way you would do it – in business … 😉 The SAS specialization consists of over 150 hours of SAS learning material and • a SAS quarterly students online live school (3 days on topics such as analytics trends, analytics lifecylce, SAS Viya environment, turning data into value, usecases, Certification preperation) • a choice of 2 different elearning pathways • 2 online certifications that you need to pass It results in a dedicated, jointly signed certificate and badge (HSLU and SAS). It gets you the SAS skills, the ECTS credits, and an excellent boost in career. There are two pathways available to reach the SAS Specialization. Choose your pathway depending on your interest. **1: Visual Analytics and Modeling** • SAS quarterly student school (3 days web-based live course) • **Visual Business Analyst (2 elearnings and 1 online certification to complete)** • **Visual Modeling Specialist (1 elearning and 1 online certification to complete)** **2: Machine Learning and SAS Programming** • SAS quarterly student school (3 days web-based live course) • **SAS Base Programming Specialist (2 elearnings and 1 online certification to complete)**

	• **Machine Learning Specialist (1 elearning and 1 online certification to complete)** For the successfully completed pathway and passed certifications, students will get 6 ECTS credits applied towards the general core elective modules as well as the joint certificate and badge. The SAS certifications are free of charge for our students. **How to apply:** https://www.hslu.ch/en/lucerne-school-of-business/degree-programmes/master/applied-information-and-data-science/joint-certificate-sas/
Module type	General core elective module
Form	External Course (SAS)
ECTS credits	6 ECTS Credits
Teaching language	English
Head	Markus Grau
Adjunct lecturers	None

Module positioning	
Admission requirements	Applied Machine Learning and Predictive Modelling 1 (W.MSCIDS_MPM02.18)
Recommended semester	None
Remarks	

Module objectives	
Overall objective	Joint Certificate | Lucerne University of Applied Sciences and Arts (hslu.ch) Intro Video (short): Why SAS? Why this Joint Certification and why this might be great for your Career? - YouTube **And on ILIAS: 03_SAS-courses**
Objective: **Professional skills**	Organizations face increasing demands for high-powered analytics that produce fast, trustworthy results. The SAS Viya platform enables everyone – data scientists, business analysts, developers and executives alike – to collaborate and realize innovative results faster. www.sas.com/viya **SAS Visual Analytics (VA)** is a part of SAS Viya and provides an interactive user experience that combines advanced data visualization, an easy-to-use interface and powerful in-memory technology. This lets users visually explore data, execute analytics and understand what data means. SAS VA complements other technologies like programming, with the focus of seeing the big picture and underlying connections faster! www.sas.com/va

	SAS Visual Data Mining and Machine Learning (ML) is a part of SAS Viya platform and supports the end-to-end data mining and machine learning process with a comprehensive visual – and programming – interface. It mpowers analytics team members of all skill levels with a simple, powerful and automated way to handle all tasks in the analytics life cycle. SAS ML complements other technologies with the focus of seeing the big picture and underlying connections faster! www.sas.com/vdmml
Objective: **Problem-solving and critical thinking**	
Objective: **Method skills**	
Objective: **Communication skills**	
Objective: **Interpersonal skills**	

Contents	
Pathway 1: **a) SAS Visual Analytics 1 for SAS Viya – Basics and** **SAS Visual Analytics 2 for SAS Viya – Advanced** **b) SAS Visual Statistics and interactive Model Building**	**SAS Visual Analytics** (2 Modules) Getting Started with SAS Visual Analytics Preparing Data in SAS Visual Analytics Analyzing Data in SAS Visual Analytics Designing Reports with SAS Visual Analytics https://support.sas.com/edu/schedules.html?crs=YVA1&ctry=ch#s1=1 SAS Visual Analytics Overview Restructuring Data for Geographic Mapping Restructuring Data for Forecasting Performing Network Analysis Performing Path Analysis Performing Text Analytics Creating Advanced Data Items Creating Advanced Filters Using Parameters to Create Advanced Reports https://support.sas.com/edu/schedules.html?crs=YVA2&ctry=ch#s1=1 **Visual Statistics / Model Building** • Building and exploring descriptive models • Building and exploring predictive models with continuous and categorical targets • Performing model validation • Assessing model goodness of fit • Modifying and comparing models • Scoring models.

	https://www.sas.com/de_ch/certification/credentials/bi-analytics/visual-statistics-84.html
Pathway 2: **a) SAS® Programming 1: Essentials and SAS® Programming 2: Data Manipulation Techniques** **b) SAS® Machine Learning Specialist**	**SAS Programming** (2 Modules) Essentials Accessing Data Exploring and Validating Data Preparing Data Analyzing and Reporting on Data Using SQL in SAS SAS Training in the United States -- SAS® Programming 1: Essentials Controlling DATA Step Processing Manipulating Data with Functions Creating Custom Formats Combining Tables Processing Repetitive Code Restructuring Tables SAS Training in the United States -- SAS® Programming 2: Data Manipulation Techniques **SAS Machine Learning Specialist** • Apply the analytical life cycle to a business need. • Incorporate a business-problem-solving approach in daily activities. • Prepare and explore data for analytical model development. • Create and select features for predictive modeling. • Develop a series of supervised learning models based on different techniques such as decision trees, ensembles of trees (forest and gradient boosting), neural networks, and support vector machines. • Evaluate and select the best model based on business needs. • Deploy and manage analytical models under production. SAS Training in the United States -- Machine Learning Using SAS Viya
Topic 4: Application	How to register on Skillbuilder is explained here: ILIAS: 03_SAS-Courses

Teaching and learning

Coursework:	**Hours**	**Hours (%)**
Contact hours		
Coaching		
Self-study		
Other		
Total	**150 hrs**	**100.0%**

Details on teaching and learning methods:

Teaching and learning methods: **Classroom**	

Teaching and learning methods: **Coaching**	
Teaching and learning methods: **Self-study**	In order to get the technical certification, you need to go – besides the elearning - through all the material additionally provided. Also, you need to do the practical tasks on SAS Viya for Learners as well as the certification preparation.
Teaching and learning methods: **Other**	

Assessments

(Adaptions are possible at any time.)

Assessments	**Assessment 1**	**Assessment 2**
Type of performance record Pathway 1	External certification / validation. See exam content: https://www.sas.com/en_us/certification/credentials/bi-analytics/visual-business-analytics.html	External certification / validation. See exam content: https://www.sas.com/de_ch/certification/credentials/bi-analytics/visual-statistics-84.html
Type of performance record Pathway 2	External certification / validation. See exam content: Base Programming Specialist | SAS	External certification / validation. See exam content: Machine Learning Specialist | SAS
Scope		
Date	flexible	flexible
Weighting (if two assessments)	Both exams must be passed!	Both exams must be passed!
Aids/materials	None	None

Notes on the assessments:

Language	English
Certificates	Exam via Pearon Vue
Attendance	Virtual or on a external Testcenter in Lucerne: Pearson VUE - Test Center Information

Teaching material

Literature	
Lecture notes	

Online resources	Various. All listed in the SAS Skillbuilder Platform, a certification platform specifically for students. www.sas.com/skillbuilder
Software	SAS Viya for Learners and/or SAS Virtual Lab (SAS Studio for SAS Programming)
Other resources	Remark: The certification websites etc. mentions also prices They are intended for commercial users. The SAS Skillbuilder Program is totally free of charge!

Scientific Writing and Presentation Skills – Input and Coaching

Module description	
Module code	W.MSCIDS_CW03.22
Module name	Scientific Writing and Presentation Skills – Input and Coaching
Most recent change	July 2023
Module concept	This module is designed to support students during their Preliminary Thesis writing. The module provides input on oral and written communication skills and coaching in the context of the student's thesis project. As such, this module focuses on what it takes to communicate particular knowledge comprehensibly and convincingly to a specialist audience in English. The module structure is as follows: -Two inputs on scientific presentation -Two inputs on scientific writing -Coaching sessions on scientific presentation (group or individual) -Coaching sessions on scientific writing (group or individual)
Module type	General Core Elective Module
Form	Regular Course (weekly)
ECTS credits	3 ECTS Credits
Teaching language	The input and coaching sessions on scientific writing will be offered in English **AND** German. The presentation input is offered in English only. Students can chose the language (English or German) of their Preliminary Master's Thesis and presentation.
Head	Vinzenz Rast Martin Gutmann
Adjunct lecturers	

Module positioning	
Admission requirements	Enrollment in the preliminary study for the Master's Thesis
Recommended semester	3rd semester
Remarks	Please note that because this module relates directly to and assesses students on the Preliminary Master's Thesis, it is not possible to participate in this module without simultaneously writing the Preliminary

	Master's Thesis. If a student in the module receives permission from the IDS program management to postpone the submission of their Preliminary Thesis, the assessment for this module will also be postponed until the following semester.

Module objectives	
Overall objective	Students are able to apply the conventions of scientific writing and can plan how to communicate their research findings convincingly in a culturally appropriate manner to a given audience in English.
Objective: **Professional skills**	Students - understand the basic forms of scientific writing - understand the APA citation standards - are able to systematically plan, structure, write and edit scientific texts - are able to communicate scientific content by using a range of written and oral formats - are able to analyze, define and meet the expectations of the audience of their presentations - are able to design and visualize culturally appropriate presentation content - are able to hold a well-structured and convincing scientific presentation
Objective: **Problem-solving and critical thinking**	Students are able to identify the main aspects of a task involving the communication of scientific content
Objective: **Method skills**	Students - are able to apply the important tools for researching, preparing and presenting scientific content - are able to consider Anglo-American expectations when designing convincing presentations
Objective: **Communication skills**	Students understand the appropriate language and cultural conventions for communicating scientific content in written and spoken form.
Objective: **Interpersonal skills**	Students understand that stakeholder needs and culture-based expectations must be defined and met.
Objective: **Personal skills**	Students are able to reflect on the presentation style specific to their culture.

Contents	
Topic 1: **Style**	Style characteristics of scientific writing in English and German (depending on student's language choice). Success factors in preparing an international, scientific presentation in English
Topic 2: **Planning**	Planning, structuring, editing, and revising scientific texts, as well as language norms and conventions in scientific writing

	Structure, elements, visualization and choreography of scientific presentations in international settings
Topic 3: **Success factors**	Understanding the success factors in situations where effective spoken language counts
Topic 4: **Spoken communication**	Forms of spoken communication: Presentation (defense of the Master's Thesis, contribution at a conference, etc.)
Topic 5: **Anglo-American conventions**	Applying Anglo-American conventions as encountered in a range of scientific settings.

Teaching and learning		
Coursework:	**Hours**	**Hours (%)**
Contact hours	21 hrs	23%
Coaching	21 hrs	23%
Self-study	48 hrs	54%
Other		
Total	**90 hrs**	**100.0%**

Details on teaching and learning methods:

Teaching and learning methods: **Classroom**	Four initial input sessions followed by training and coaching
Teaching and learning methods: **Coaching**	Coaching for the two assessments
Teaching and learning methods: **Self-study**	Studying the literature, planning, writing, designing presentations including appropriate visualizations.
Teaching and learning methods: **Other**	None

Assessments
(Adaptions are possible at any time.)

Assessments	**Assessment 1**	**Assessment 2**
Type of assessment	Preliminary study for the Master's Thesis (scientific writing) Individual work	Recorded Presentation (narrated Power Point) of the Preliminary Study for the Master's Thesis Individual presentation

Evaluation type	Pass/fail	Pass/fail
Scope		8 to 10 minutes
Dates	During the semester	Due in Week 14 of Semester
Weighting (if two assessments)	50%	50%
Aids/materials	-	-

Notes on the assessments:

Language	German or English (free of choice)
Certificates	None
Attendance	None

Teaching materials

Literature

Alley, M. (2013). *The Craft of Scientific Presentations* (2 ed.). New York: Springer.
Bendel, S. (2012). Wissenschaftliche Texte verfassen. Unveröffentlichtes Typoskript. Lucerne School of Business.
Booth, W., et.al. (2003) *The Craft of Research*. Chicago: University of Chicago Press.
Cialdini, R. B. (2009). *Influence: The Psychology of Persuasion* (revised ed.). New York: HarperCollins. Retrieved November 9, 2016, from https://mafhom.files.wordpress.com/2014/03/influence.pdf
Conger, J. A. (2013). The Necessary Art of Persuasion. In *HBR's 10 Must Reads on Communication* (pp. 67-89). Boston: Harvard Business Review Press.
Duarte, N. (2012). *HBR Guide to Persuasive Presentations.* Boston: Harvard Business School Publishing Corporation.
„Eulenskript" (Ausgabe 2022). *Vorgaben für die formale Gestaltung wissenschaftlicher Arbeiten an der Hochschule Luzern – Wirtschaft.* [Unveröffentlicht. Typoskript], Lucerne School of Business. Retrieved on 31 May 2023 von https://www.zhbluzern.ch/fileadmin/zhbluzern/standorte/hslu-w/pdf/Eulenskript_2020.pdf
Frischherz, B. & Demarmels, S. & Aebi, A. (2017). Wirkungsvolle Reden und Präsentationen vorbereiten – halten – auswerten. 3. überarbeitete und erweiterte Auflage. Zürich: Versus.
Hofstede, G. (n.d.). *Cultural Dimensions: National Culture.* Retrieved on September 1, 2016, from Geert Hofstede: https://www.geert-hofstede.com/national-culture.html
Hofstede, G., Hofstede, G. J., & Minkov, M. (2010). *Cultures and Organizations: Software of the Mind* (3rd rev. ed.). Maidenhead: McGraw-Hill.
Kruse, O. (2010): *Lesen und Schreiben. Der richtige Umgang mit Texten im Studium.* Konstanz: UVK.
Millar, G. (2018). Writing Dissertations: A Guide. Based on the *Publication Manual of the American Psychological Association*. Unpublished document, Lucerne School of Business.
Wong, D. M. (2010). *Guide to Information Graphics: The Dos and Don'ts of Presenting Data, Facts, and Figures*. New York: Norton.

	Zelazny, G. (2009). *Wie aus Zahlen Bilder werden. Der Weg zur visuellen Kommunikation – Daten überzeugend präsentieren* (6., überarbeitete Auflage). Wiesbaden: Gabler.
Online resources	Lucerne School of Business. *Empirical Methods. Forschungsprozess.* retrieved on 21 May 2019 from https://www.empirical-methods.hslu.ch/forschungsprozess/qualitative-forschung/
Other resources	None

Sports Data Analytics

Module description	
Module code	W.MSCIDS_DE_SDA01.20
Module name	Sports Data Analytics
Most recent change	July 2021
Module concept	The economic importance of sports data is increasing, and the sports analytics market is growing very rapidly [1][2][3]. At the same time, the context surrounding the sports industry varies enormously in terms of its requirements on data. Different sport types and interpretations of expert call for analyses spanning the entire range of options. The sports markets are also very diverse and include broadcasting, fan engagement, performance diagnostics, scouting and betting. However, there are underlying generic principles in this richly varied data landscape. Students learn the most important principles and can apply them to simple practical examples. References: [1] Sports Analytics Market by Sports Type (Individual and Team), Component, Application (Performance Analysis, Player Fitness and Safety, Player and Team Valuation, and Fan Engagement), Deployment Model, and Region - Global Forecast to 2024, https://www.marketsandmarkets.com/Market-Reports/sports-analytics-market-35276513.html [2] Sports Analytics Market-Growth, Trends and Forecast (2019-2024), Mordor Intelligence: https://www.orbisresearch.com/reports/index/sports-analytics-market-growth-trends-and-forecast-2019-2024 [3] Sports Player Tracking and Analytics: Market Shares, Strategies, and Forecasts, Worldwide, 2017 to 2023, Wintergreen: https://wintergreenresearch.com/sports-analytics
Module type	Core Elective Module – Domain Experience
Form	Block Seminar on site (autmn semester: Feb. / spring semester: Aug./Sept.)
ECTS credits	3 ECTS Credits
Teaching language	English
Head	Martin Rumo
Adjunct lecturers	None

Module positioning	
Admission requirements	none

Recommended semester	none
Remarks	none

Module objectives	
Overall objective	– Students gain an overview of the sports analytics market and can evaluate its products. – They will learn how to model, analyze and visualize performance in sports.
Objective: **Professional skills**	– Understand the most common measurement technologies and data collection methods. – Select and apply analytical methods for extracting information from data sets to answer technical questions. – Understand the legal aspects of sports data.
Objective: **Problem-solving and critical thinking**	– Students are able to transform specific performance factors into key indicators in sports and explain how these connections can be observed in sports data. – They should also be able to identify the strengths and weaknesses of their own work.
Objective: **Method skills**	– Students are able to set up meaningful models that express performance in numbers and to communicate these numbers with appropriate visualization methods. – They are also able to consider the nature of the competition when using statistics.
Objective: **Communication skills**	– Students are able to present their work convincingly. – They are able to communicate the purpose, approaches and main results of their work, as well as the conclusions they have drawn.
Objective: **Interpersonal skills**	– Students should be self-critical about their work and accurately identify its weaknesses.

Contents	
Topic 1: **Phenomena Sport**	– Understand the phenomena Sport – Understand the skill vs. luck ratio in Sport – Understand the general use of data in Sport
Topic 2: **Methodological Approaches**	– Know different measurement technologies – Understand how data is organized, analyzed and presented
Topic 3: **Areas of Applications**	– Getting familiar with the following areas of applications: o Analytics o Profiling / Scouting o Athlete Development o Content Generation

Topic 4: **Sports Data Analytics as a Business**	– Understanding value chains in the Sports industry – Understanding how data is monetized in the Sport industry

Teaching and learning

Coursework:	**Hours**	**Hours (%)**
Contact hours	30 hrs	33.3%
Coaching	30 hrs	33.3%
Self-study	30 hrs	33.3%
Other		
Total	**90 hrs**	**100.0%**

Details on teaching and learning methods:

Teaching and learning methods: **Classroom**	Discussion-based lessons
Teaching and learning methods: **Coaching**	Further study and application of the theories when completing different practical tasks
Teaching and learning methods: **Self-study**	Reading about the topic.
Teaching and learning methods: **Other**	None

Assessments

(Adaptions are possible at any time.)

Assessments	**Assessment 1**
Type of assessment	Students have to hand in a dossier consisting of Jupyter notebooks. These notebooks contain deeper analysis of some of the tasks given during the module. It is recommended to form groups in which the tasks are solved and the notebooks discussed. The dossiers will be evaluated individually.
Evaluation type	Grade
Scope	
Dates	During the block seminar - according to the lecturer's information
Weighting (if two assessments)	100%

Aids/materials	None

Notes on the assessments:

Language	German or English (free of choice)
Certificates	None
Attendance	100%

Teaching materials	
Literature	Students will receive the lecture slides with the optional suggestions for further reading at the beginning of the semester.
Lecture notes	None
Online resources	Based on the lecture slides
Software	Jupyter Notebooks Scraping Software
Other resources	None

Sustainability Analytics

Module description	
Module code	W.MSCIDS_DE_SUA01.22
Module name	Sustainability Analytics
Most recent change	December 2022
Module concept	To ensure long-term viability of businesses, societies, and humanity, it has become imperative to incorporate ecological, societal, and economical long-term consequences into business decisions, product design, and public policies and to report on them. Also, it is important to make our infrastructures, societies, and businesses resilient against large-scale sudden and gradual impacts of changes such as climate change. Sustainable, balanced products, strategies, investments, and reports require state-of-the-art analytics and models which master the long-term nature of the challenges and the interconnectedness of almost all relevant domains of our life. Moreover, the largely unprecedented nature of sustainability problems impose additional challenges to data analytics. In this module, we - get an overview of the challenges, scientific domains, approaches, and methods; - know the diversity of relevant applications; - connect relevant data and domains using appropriate methods; - access the rich scientific, modeling, and analytics tool kits to help solve the problems; and - integrate communities, data, and methods; gaining hands-on experience while solving a real-life challenge in the area of climate change or an area of the team's own choice.
Module type	Elective Module – Domain Experience
Form	Block Seminar on site (autumn semester: February / spring semester: Aug.or Sept.)
ECTS credits	3 ECTS Credits
Teaching language	English
Head	Salomon Billeter
Adjunct lecturers	David Bürgisser will be leading and coaching the systems tools and stakeholder engagment topics.

Module positioning	
Admission requirements	None
Recommended semester	2nd Semester
Remarks	The block week is carried out as onsite coworking sessions with coaching. A classroom setting will be used for input sessions and may be used for selected topics emerging from the coworking sessions during the block week.

Module objectives	
Overall objective	The students are able to employ analytics to help solving sustainability-related problems including climate change and thereby support the transition to more sustainable and resilient products, businesses, and societies.
Objective: **Professional skills**	They get an overview of the challenges, scientific domains, approaches, and methods. They know the diversity of relevant applications and corresponding methodologies. They know how to acquire the relevant domain knowledge.
Objective: **Problem-solving and critical thinking**	They solve a real-life challenge in the area of climate change or an area of the students' own choice, gaining hands-on experience. They gain an overview of the applicability of scientific and analytics methods to help solve their challenge.
Objective: **Method skills**	They connect relevant data and domains using appropriate analytics methods. They know and connect a wide tool kit of methods ranging from data integration via time-series analysis and lifecycle analysis to integrated assessment modeling and dynamic simulation.
Objective: **Communication skills**	They communicate the results of their challenge in an engaging and compelling way.
Objective: **Interpersonal skills**	They are able to engage with stakeholders with different objectives, to elicit and incorporate their views, and to link them to quantitative trade-offs.

Contents	
Topic 1 (15%): **Sustainability**	Examples will illustrate each aspect of sustainability. Sustainability background: - From "Limits of Growth" to UN Sustainable Development Goals - Climate change, climate mitigation and adaptation, planetary boundaries - ESG reporting and regulatory landscape Employment of analytics in sustainability: - Decision support (analytics, simulation, integrated assessment), planning - Reporting, life cycle cost-benefit analysis - Product innovation - Systems innovation
Topic 2 (50%): **Challenge**	A challenge is selected in the area of climate change in Switzerland and solved in small groups as a common thread throughout the module. A data set will be provided as a starting point for data integration, and a method will be provided as a starting point for the analytics. The work in the challenges is prepared before and carried out during the block week. The challenge will encompass a system overview, data integration, analytics, and modeling, stakeholder engagement, and communication of results.
Topic 3 (25%): **Analytics methods**	The tool kit is outlined to establish an overview. As a preparation of the block week, the elements employed in the challenges are provided more in-depth. The tool kit contains:

	- Techniques for integration of data especially relevant for sustainability - Analytics tool kit from regression and time-series analysis via data sourcing with choice experiments to elaborate models such as system dynamics and integrated assessment models which are however only outlined - A brief overview of the relevant domains is provided, ranging from natural sciences (climate, biodiversity, planetary boundaries) to the humanities (focus on economic considerations)
Topic 4 (10%): **Stakeholder engagement**	Tool kit for use in the stakeholder engagement part of the challengs is outlined: System maps, theories of change, and other tools.

Teaching and learning		
Coursework:	**Hours**	**Hours (%)**
Contact hours	18 hrs	20%
Coaching (outside block week)	9 hrs	10%
Self-study	27 hrs	30%
Other (coworking with and without coaching)	36 hrs	40%
Total	**90 hrs**	**100%**

Details on teaching and learning methods:

Teaching and learning methods: **Classroom**	The following topics are briefly outlined and illustrated in a classroom setting: - Topic 1 "Sustainability" - Topic 3 "Analytics methods" The classes alternate with coaching and self-study. The topics and form are communicated ahead of time. The classroom training will provide the techniques needed to solve the challenge, and it will provide an overview of the area. On request, dedicated session will illustrate chosen topics more in-depth.
Teaching and learning methods: **Coaching**	Coaching and professional support is provided for all topics. The choice of topics is driven by the students.
Teaching and learning methods: **Self-study**	Self-study and team work is required for all topics and focuses on - Topic 2 "Challenge" as a common thread
Teaching and learning methods: **Other**	The block week will be used to conclude the challenge and will focus on - Topic 2 "Challenge" - Topic 4 "Stakeholder engagement"

Assessments (Adaptions are possible at any time.)		
Assessments	**Assessment 1**	**Assessment 2**
Type of assessment	Presentation of the results of the challenge	Brief summary report with documented data analysis
Evaluation type	Grades	Grades
Scope	15 minutes presentation, Q&A session	Report with abstract, problem statement, system map, data analytics, results, and conclusions in a concise and reproducible form
Date	During the block seminar	At the end of the block seminar
Weighting (if two assessments)	40%	60%
Aids/materials	Presentation	Jupyter notebook, R notebook, or equivalent

Notes on the assessments:

Language	German or English (free of choice)
Certificates	None
Attendance	Attendance required during the first module day, the challenge selection day, and the block week.

Teaching material	
Literature	References will be compiled into the class notebook ahead of, during, and after the classes
Lecture notes	Class notebook (MS Teams) – teacher notes and collaboration notes
Online resources	IPCC, Idaweb (Meteoschweiz), Open Data Switzerland, BAFU (Federal Office for the Environment)
Software	Some examples will be shown in R Studio For the challenge: Own choice, e.g. R notebook or Jupyter notebook
Other resources	Will depend on the challenge

Time Series Analysis in Finance

Module description	
Module code	W.MSCIDS_DE_TSA01.18
Module name	Time Series in Finance
Most recent change	March 2021
Module concept	Financial markets are social systems with unique characteristics. Accordingly, they have certain time series that cannot be replicated and often exist only in limited form. Nevertheless, there is strong demand for analyses and models in the applied field. In this module, students do practical work and discover how data scientists apply concepts from this dynamic field and deliver meaningful results.
Module type	Core Elective Module – Domain Experience
Form	Regular Course (weekly)
ECTS credits	3 ECTS Credits
Teaching language	English
Head	Thomas Ankenbrand
Adjunct lecturers	Denis Bieri

Module positioning	
Admission requirements	none
Recommended semester	2nd semester
Remarks	none

Module objectives	
Overall objective	Students analyze and model time series of financial markets.
Objective: **Professional skills**	Students understand the characteristics of financial market time series, which reflect not only the characteristics of such markets as a social system but also the operational conditions of market players.
Objective: **Problem-solving and critical thinking**	Students are able to apply appropriate methods adequately and pragmatically.
Objective: **Method skills**	Students get to know a number of basic time series models and know when and how to apply them.

Objective: **Communication skills**	Students are able to explain the economic, methodological and applied aspects of their analyses and models.
Objective: **Interpersonal skills**	None
Objective: **Personal skills**	Students are able to discuss the opportunities, risks and limitations of time series analysis in financial markets.

Contents	
Topic 1: **Principles of financial markets**	Financial markets as social systems Market mechanisms and infrastructure Overview of the fields of application Consequences for time series analyses
Topic 2: **Applied fields**	Risk management Portfolio management (Markowitz, CAPM) Forecast models Crypto assets High frequency trading Macroeconomic time series Behavioral finance
Topic 3: **Applied methods**	Setting up the environment for analyzing/modeling time series models Data preparation Data decomposition Descriptive statistics (distribution functions, central moments, stationarity, correlations) Time series models (autoregression, moving average, ARMA, ARIMA) Vector autoregressive models Estimation techniques (ordinary least square, maximum likelihood)
Topic 4: **Application**	Pitch and discussion of solutions

Teaching and learning		
Coursework:	**Hours**	**Hours (%)**
Contact hours	30 hrs	33.3%
Coaching	30 hrs	33.3%
Self-study	30 hrs	33.3%
Other		
Total	**90 hrs**	**100.0%**

Details on teaching and learning methods:

Teaching and learning methods: **Classroom**	Discussion-based lessons
Teaching and learning methods: **Coaching**	Own case study to further explore and apply the theories learned
Teaching and learning methods: **Self-study**	Own case study to further explore and apply the theories learned
Teaching and learning methods: **Other**	None

Assessments

(Adaptions are possible at any time.)

Assessments	**Assessment 1**	**Assessment 2**
Type of assessment	Presentation of a case study (group work)	Written paper on the case study
Evaluation type	Grades	Grades
Scope	5-min. presentation	5 pages
Dates	During the semester - according to the lecturer's information	During the semester - according to the lecturer's information
Weighting (if two assessments)	50%	50%
Aids/materials	None	None

Notes on the assessments:

Language	English
Certificates	None
Attendance	80%

Teaching materials

Literature	1. Kleiber, Ch. & Zeileis, A. (2008). Applied Econometrics with R. Springer Verlag. 2. Hadley, Wickham & Garret, Grolemund. (2019). R for Data Science. Fourth Edition. Springer Verlag.
Lecture notes	PowerPoint, RScripts
Online resources	Datacamp

Software	R with RStudio
Other resources	Videos

Open Government Data with Tableau

Module description	
Module code	W.MSCIDS_DE_ODS01.23
Module name	Open Government Data with Tableau
Most recent change	June 2023
Module concept	Open data infrastructures play an important role and rely on a range of sources, including communities of volunteers as well as companies and public institutions. This module focuses on how to access and visualize this type of data and thus contribute to the further development of the open data infrastructure in a specific industry. Not only are technical aspects and the advantages and disadvantages of Open Government Data discussed, but they are also visually processed using Tableau to generate insights that would not be apparent from the data itself. You will learn how to link Open Government Data with Spatial Data and present it in a meaningful way, including interactive dashboards.
Module type	Core elective module – Domain Experience
Form	Regular Course (weekly)
ECTS credits	3 ECTS Credits
Teaching language	English
Head	Andreas Hüsser
Adjunct lecturers	

Module positioning	
Admission requirements	none
Recommended semester	none
Remarks	none

Module objectives	
Overall objective	Students are able to visualize and develop parts of an open data infrastructure with Tableau Desktop and to extract additional value from data. While doing so, they will learn about the benefits of open data and how to structure and develop it further. Students will also learn how to prepare the data using Tableau Prep to put it into a form that is readable by Tableau and usable for analysis. Students will be taught the fundamentals of Tableau, including how to create interactive dashboards

	and how to create interactive maps based on open geospatial data (OpenStreetMap).
Objective: **Professional skills**	Comparison of different open data policies in selected countries, including an evaluation of their advantages and disadvantages, as well as a solid working knowledge of Tableau Prep and Tableau Desktop.
Objective: **Problem-solving and critical thinking**	Evaluation of the possibilities and limitations of open data based on a solution that students design themselves.
Objective: **Method skills**	Data visualization by using open data and geospatial data, with a view to putting it to practical use with the Software Tableau Desktop.
Objective: **Communication skills**	None
Objective: **Interpersonal skills**	None
Objective: **Personal skills**	Students clarify their ideas about the relationship between open and closed data structures.

Contents	
Topic 1: **Introduction to the topic**	Open data, shared data, my data, data space, data commons, linked data. Students will receive a comprehensive overview of the topic as well as the advantages and disadvantages of Open Data for civil society, government agencies and public services, as well as businesses.
Topic 2: **Data preparation**	Students learn about the problems of Open Data. Often, these are extensive and messy data sets with missing values that first have to be prepared and put into a usable form for analysis using Tableau Prep. In the process, students will learn how to pivot rows and columns, how to link different data sources to each other with joins, and how to aggregate the data.
Topic 3: **Visualizing data**	In this part, students learn the fundamentals of Tableau. This includes innovative visualizations and dashboards, the use of calculated fields for own calculations, sets and parameters for interactivity, as well as the use of level of detail expressions and the use of OpenStreetMap with geospatial data from the Swiss Federal Office of Statistics.
Topic 4: **Insights from practice**	Guest lecture by Martin Soutschek from OutdoorActive. Martin Soutschek will give an insight into how Open Data can be profitably used in practice and how Open Data can be integrated into a business model. This will be illustrated using a wide variety of use cases.

Teaching and learning		
Coursework:	**Hours**	**Hours (%)**
Contact hours	18 hrs	20 %

Tableau	24 hrs	27 %
Self-study	48 hrs	53 %
Other		
Total	**90 hrs**	**100.0%**

Details on teaching and learning methods:

Teaching and learning methods: **Classroom (on-site)**	Lessons on-site in class, including presentations and Tableau Desktop and Tableau Prep lessons an on-site coaching for group and individual works.
Teaching and learning methods: **Online**	Lessons online via Zoom on Tableau Desktop and Tableau Prep.
Teaching and learning methods: **Self-study**	48 hours for designing, further developing and improving the existing open data infrastructure in tourism in cooperation with practice partners.
Teaching and learning methods: **Other**	None

Assessments

(Adaptions are possible at any time.)

Assessments	**Assessment 1**	**Assessment 2**
Type of assessment	Students visualize the tourism Hotel and accommodation data or another task relating to an applied field (e.g., education, labor and acquisition, science, energy, finance, geography, commerce, agriculture and forestry, energy, health, etc.) in Tableau Desktop.	Students work individually on a task they can chose from.
Evaluation type	Grade per group	Grade per student
Scope	Submission of the group work in electronic form (Tableau Packaged Workbook).	Submission of the individual work in electronic form (Tableau Packaged Workbook) and accompanying documentation with explanations and an evaluation of the advantages and disadvantages of open data.
Dates	During the semester - according to the lecturer's information	During the semester - according to the lecturer's information
Weighting (if two assessments)	50%	50%
Aids/materials	None	None

Notes on the assessments:

Language	German or English (free of choice)
Certificates	None
Attendance	No.

Teaching materials	
Literature	Will be provided upon request (not mandatory for the course): • Kitchin, R. (2022). The data revolution. A critical analysis of big data, open data & data infrastructures (2nd edition). Sage Publications. • Sleeper, R. (2018). Practical Tableau. O'Reilly. • Sleeper, R. (2020). Innovative Tableau. O'Reilly. • Allchin, C. (2020). Tableau Prep up & running. O'Reilly. • Loth, A. (2021). Datenvisualisierung mit Tableau (2. Auflage). Mitp. • Kleine, H. (2021). Tableau Prep cookbook. Packt Publishing. • Wilke, C. O. (2019). Fundamentals of data visualization. O'Reilly. • Kirk, A. (2019). Data visualization. A handbook for data driven design (2nd edition). Sage Publications.
Lecture notes	Presentations and Tutorials.
Online resources	Swiss Open Government Data https://opendata.swiss/de Swiss Tourism Data https://www.tourismdata.ch/ Open Data Hub https://opendatahub.com/ European Open Data https://data.europa.eu/en Transport for London https://tfl.gov.uk/info-for/open-data-users/ Open Travel Alliance https://opentravel.org Swisscom Open Data Portal https://opendata.swisscom.com/pages/home/ SBB Open Data Portal https://data.sbb.ch/pages/einstieg/?flg=de Swiss Open Transport Data https://opentransportdata.swiss/de/
Software	Tableau Desktop for data visualization. Tableau Prep and R for Statistical Computing for data manipulation and preparation.
Other resources	None

Web and Data Scraping with R

Module description	
Module code	W.MSCIDS_WDS02.20
Module name	Web and Data Scraping with R
Most recent change	July 2021
Module concept	Online platforms such as Yelp, Twitter, Amazon, or Instagram are large-scale, rich and relevant sources of data. Researchers in the social sciences increasingly tap into these data for field evidence when studying various phenomena. In this course, you will learn how to find, acquire, store, and manage data from such sources and prepare them for follow-up statistical analysis and data science projects. After a short introduction we will briefly review R as a programming language and its basic data formats. We will then use R to program simple scrapers that systematically extract data from websites. We will use the packages rvest, httr, and RSelenium, among others, for this purpose. You will further need to learn how to read HTML, CSS, JSON, or XML codes, to use regular expressions, and to handle string, text and image data. To store the data, we will look into relational databases, (My)SQL, and related R packages. Many websites such as Twitter and Yelp offer convenient application-programming interfaces (APIs) that facilitate the extraction of data and we will look into accessing them from R. Finally, we will highlight some options for feature extraction from images and text, which allows us to augment our collected data with meaningful variables we can use in our analysis. At the end of this course, students should be able to identify valuable online data sources, to write basic scrapers, and to prepare the collected data such that they can use them for statistical analysis as part of their own research projects. Throughout the course, students will work on a data-scraping project. This project will be presented at the end of the course. All data scraping code and other sources will be made available on https://www.data-scraping.org.
Module type	General Core Elective Module
Form	Online Block Seminar (autumn semester: Feb. / spring semester: Aug. or Sept.)
ECTS credits	3 ECTS Credits
Teaching language	English
Head	Reto Hofstetter
Adjunct lecturers	1-2 guest presentations from data scraping experts

Module positioning	
Admission requirements	– Applied Machine Learning and Predictive Modelling 1 (W.MSCIDS_MPM02.18) – R-Bootcamp (W.MSCIDS_RB01.19)

Recommended semester	3rd Semester
Remarks	

Contents	
Topics:	– Intro to data scraping – Define students' scraping projects – Review of R and introduction to programming with R – R programming exercises – The anatomy of the internet and relevant data formats – Intro to web scraping with R (with httr, rvest, RSelenium) – Introduction to APIs – Scraping exercises – Relational Databases and SQL – Data management with R – Database design and implementation project (with MySQL in the cloud) – Scraping examples from Yelp, Crowdspring, Twitter, and Instagram – Scaling up your scraper with parallel code and proxies – Feature extraction examples – Guided independent work on scraping projects

Teaching and learning		
Coursework:	**Hours**	**Hours (%)**
Contact hours	30 hrs	33.3%
Coaching	30 hrs	33.3%
Self-study	30 hrs	33.3%
Other		
Total	**90 hrs**	**100.0%**

Assessments
(Adaptions are possible at any time.)

Assessments	**Assessment 1**	**Assessment 2**
Type of performance record	Presentation of a project and submission of the presentation in a PDF file; further information will follow.	
Evaluation type	Grade	
Scope	Submission of a report (approx. 15 pages) and the presentation of own work in a video (approx. 15 min.)	

Date	During the block seminar - according to the lecturer's information	
Weighting (if two assessments)	100%	
Aids/materials	None	

Notes on the assessments:

Language	German or English (free of choice)
Certificates	n/a
Attendance	80% attendance requirement

Teaching materials

Literature	▪ Hofstetter, R. (2020), Data scraping: The automated extraction of rich and large-scale datasets from digital sources, Work in Progress. ▪ Munzert, S., Rubba, C., Meißner, P., & Nyhuis, D. (2014). Automated data collection with R: A practical guide to web scraping and text mining. John Wiley & Sons. ▪ Aydin, O. (2018). R Web Scraping Quick Start Guide: Techniques and tools to crawl and scrape data from websites. Packt Publishing Ltd. ▪ Provost, Foster & Fawcett, Tom (2013). Data Science for Business: What You Need to Know About Data Mining and Data-Analytical Thinking. Sebastopol: O'Reilly. ▪ Schmarzo, Bill (2016). Big Data MBA: Driving Business Strategies with Data Science. Indianapolis: John Wiley & Sons. ▪ Grolemund, G. (2014). Hands-On Programming with R: Write Your Own Functions and Simulations. " O'Reilly Media, Inc.". ▪ Steiner, R. (2009). Grundkurs Relationale Datenbanken. Vieweg+ Teubner, Wiesbaden. ▪ Various online sources
Lecture notes	
Online resources	
Software	
Other resources	