Data Science for Society and Business

Master of Science

Subject-specific Examination Regulations for Data Science for Society and Business

The subject-specific examination regulations for Data Science for Society and Business are defined in this program handbook and are valid only in combination with the General Examination Regulations for master's degree programs ("General Master Policies").

This handbook also contains the program-specific Study and Examination Plan (in 2.3).

Upon graduation, students in this program will receive a Master of Science degree with a scope of 120 European Credit Transfer System (ECTS) credit points (see chapter 2 of this handbook for specifics).

Valid for all students starting their studies in Fall 2023

Version	**Valid as of**	**Decision**	**Details**
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1 Program Overview

1.1 Concept

Digital innovations are rapidly conquering all areas of social and economic life. Today, modern societies can hardly function without social media, search engines, communication and e-commerce platforms, and individualized online offers. In less than a decade, these multi-purpose technologies have become the core components of an economy and other social sectors. External shocks such as the COVID-19 pandemic has pushed digitalization toward another leap. Home office solutions, digital learning, online conferencing, telemedicine, and other digital services have become an essential part of our private, professional, and public life in no time. Meanwhile, we are permanently adding to the surging data stockpile gathered and harvested by the IT services. Research institutions, private firms, public administration, political parties, NGOs and other—including criminal—actors are already using and will continue to use "big" data to better understand, predict, and effectively intervene in issues of crucial interest to contemporary and future societies. Data may become the "new oil of the 21st century," as predicted by British mathematician Clive Humby in 2006. The second part of his famous quote is already true: Data "is valuable, but if unrefined, it cannot really be used."

The aim of this 2-year Data Science for Society and Business (DSSB) MSc program is two-fold. On the one hand, it aims to use rapidly growing digital data resources and new computational tools and methods to describe, model, predict, and potentially solve pressing business, ecological, economic, organizational, political, or other social problems and important trends like innovation diffusion, migration flows, susceptibility to infections, sustainable growth, political mobilization, and the likes. On the other hand, the program addresses the rising demand for social data science expertise and critical skills in new industries (i.e., social media, start-ups), in established sectors (i.e., production, civil and private services), common job specifications (i.e., consulting, market research, marketing), public administration (i.e., health, security), and academia (all sciences).

Hence, this study program equips students with core competencies, up-to-date skills, and tools. They will learn to identify, manage, analyze, understand, critically evaluate, and thoughtfully use digital traces to answer challenging questions on today's most progressive labor and business markets and in other social spheres. This also reflects on the dark sides of digitization and the development of sustainable countermeasures. Emerging threats can appear at all levels of the society: at an individual level, that is, in pathological computer gaming or ill-consumption of social media content, as well as at a level of organizations or entire public or economic spheres, that is, in digital espionage or manipulated social media communication. To address media bias, to identify unauthorized users, and to understand emerging problems of our digital future, we foster critical thinking in classroom discussions, enable students to develop and mature intellectual behavior, and teach how to outsmart digital crimes and build creative and corrective solutions.

The graduate program provides room for individual specialization to prepare students for an ambitious international academic or professional career. An international campus and a close communication between teachers and students provide an intellectual and social environment that offers numerous opportunities to further grow as a person.

The DSSB program also makes use of innovative learning environments and the expertise of digital natives. Blended learning is a part of it. By combining online and offline learning tools in the core and methods modules, students with diverse cultural and knowledge backgrounds, individual needs, and

personal wants can be rapidly integrated into a real classroom community. Remedial online learning will also enable individual students to close their mathematical or technical knowledge gaps according to their personal schedules. Within the classroom, students can share learning experiences, and discuss, motivate, and challenge themselves during lectures, seminars, tutorials, laboratory sessions, and field trips. They will also learn how to cooperate in social teams and how to become a valuable collaborator, and even a responsible leader in larger projects. Outside the classroom, blended learning enables each student to train, drill, and develop unique, personalized self-learning skills. The faculty advises, encourages, and supports students to think and study independently, conduct autonomous background reading, solve problems alone or in teams, and bring new ideas and solutions to seminars and tutorials for discussion.

The program enables students to improve and complement their prior knowledge not only from social sciences (e.g., business, economics, demography, human geography, management science, media studies, political science, psychology, sociology, and social history) but also from humanities, cognitive or natural sciences, or computer science—preferably with a minor in one social science field—to advance their academic, technical, and social expertise, and to realign their career plans outside and inside academia.

The MSc in DSSB is truly an interdisciplinary program. It benefits from a broad module offering that ranges from business, criminology, economics, and law to political sciences, public health, sociology, and data engineering. It cooperates closely with colleagues from non-social science disciplines and builds on modules from computer sciences, environmental sciences, and life sciences.

Given its unique interdisciplinary profile, the MSc program attracts international students with diverse backgrounds and diverse career goals. The program also meets individual diversity with its three elective tracks for the students. The Advanced Data Science track allows students with a strong mathematical and computing background to dive deeper into questions on data mining, data analytics, and machine learning. The Environment and Health track connects socially relevant data science questions with insights and techniques from natural sciences, precisely from health, medical, and environmental sciences. This track addresses students with some background and interests in demography, public health, geography, or spatial studies. The Society and Business track adds computational social science approaches and pressing questions on cybercriminology and future digital economies. It caters to students who want to focus on business administration, economics, political science, or sociology.

Beyond this specialization, the DSSB MSc graduate program offers a personalized learning environment with a smaller class size, low student-to-teacher ratio, tailor-made supervision and counseling, and career support and outplacement. Moreover, an internship during the summer break and/or second year allows the students to be immersed in a company or organizational culture and in one of the many professional careers of a data scientist.

1.2 Educational Aims

The DSSB program aims at

- teaching students to identify business problems in other social spheres (e.g., crime, economy, education, media, migration, politics, and public health) that can be best analyzed with digital data
- educating students about the evolution, social embeddedness, and social (e.g. business, economic, political) and ethical implications of digital technologies
- providing critical knowledge about cybercrime, data protection, and data ethics
- imparting knowledge about up-to-date data science concepts
- training and motivating students to learn at least fundamental programming skills in R and Python and to understand state-of-the-art computational and software tools
- achieving expertise in data analytics and modeling approaches
- conveying technical skills on how to connect and cross-validate data science studies with conventional research approaches
- guiding students to develop a critical understanding of data-driven solutions
- demonstrating why and how to apply scientific research to societal and business problems
- motivating and training how to effectively communicate and visualize scientific research results

1.3 Intended Learning Outcomes

At the end of the 2-year program, students will have acquired a strong body of expertise, both in content and in computational skills, to solve challenging problems in digital societies thoughtfully and responsibly. More specifically, graduates of the DSSB program will be able to:

1. identify, analyze, interpret, and critically assess the social (e.g., business, economic, and political) causes and consequences of the digital transformation of societies.
2. academically reflect and evaluate the legal and ethical implications surrounding privacy, data sharing, algorithmic decision making, and new business models in various digitized sectors.
3. combine data science concepts and put them into practice by developing and designing state-of-the-art applications.
4. develop scientific and professional solutions for social, ecological, economic, health, scientific, and political problems.
5. creatively and convincingly solve research implementation problems.
6. learn programming and implementation in at least one computer language (R or Python) and acquire at least basic skills in the other.
7. use state-of-the-art digital data mining methods from the Internet and other sources.
8. efficiently and securely manage social media and business data.

9. deliberately choose between, adapt, and potentially develop statistical models for “big data”.
10. elaborately command analytical, critical, and synthesizing quantitative skills to correctly model and interpret scientific results, make valid predictions, and derive thoughtful conclusions and interventions for pressing social and business problems.
11. apply innovative writing, communication, presentation techniques, and state-of-the-art visualization tools to reach out effectively and convincingly to scientific and non-scientific audiences.
12. efficiently and effectively use online and offline materials to boost self-learning and time-management skills to sharpen one’s professional expertise and stay updated in a rapidly developing scientific domain.
13. function well in an international and diverse working environment.
14. adhere to and defend ethical, scientific, and professional standards.
15. make valuable contributions to society and business.
16. grow personally to become a responsible, smart, and resilient researcher, leader, and collaborator.
17. take up an ambitious academic, business, or professional career in thriving digital domains.

1.4 Target Audience

The DSSB graduate program is a highly selective program for students with a strong background in the social sciences, such as anthropology, business, economics, demography, management science, media science, political science, psychology, social history, or sociology, who want to become a data scientist and are interested in business and social science research questions. However, we are also open to ambitious learners from humanities such as history or linguistics, natural science such as cognitive or health sciences, or other areas with a quantitative orientation. Students must be interested in working in interdisciplinary, international, and innovative research fields. The program prepares for a professional and an academic career.

1.5 Career Options

Data scientists with a focus on business and social sciences face manifold career options. The demand for their expertise is significant and growing. They can work not only in tech and for social or consulting firms but also for NGOs and international organizations; in retail, e-commerce, and telecommunication; in the finance sector; in the automotive and health industries; for public administration; and in academia. Companies and institutions in almost every domain need:

- data scientists, “big data” scientists, artificial intelligence (AI) research scientists, business intelligence analysts, computational social scientists, consultants, data analysts, data management experts, data protection specialists, financial analysts, managers, market researchers, marketing managers, medical data analysts, public affairs consultants, scientific advisors, social media analysts, web analysts, etc. Graduates of the DSSB program can work in these roles.

- experts in data analysis who (critically) evaluate, analyze, and interpret the collected digital data accurately and are able to visualize the findings clearly are also needed in public relations, journalism, political think tanks, government, police departments, and international organizations such as the World Bank, WHO, EU, UN, etc.
- experts in digital data acquisition, who can instantaneously collect the relevant data, working in all sectors of an industry
- experts in data management who know how to store, enhance, protect, and process large amounts of data efficiently work as an information security analyst, database manager, project manager, or in similar roles
- an MSc degree in DSSB also allows students to move on to a PhD and a career in academia and research institutions

The employability of DSSB graduates is promoted by organizing contacts with industry, public institutions, non-governmental organizations, and research institutes throughout the curriculum. In the first semester, in the "Digital societies and future economies" lecture, selected experts from the public and private sector and research groups introduce themselves and describe their specific interests in data science. The data science lab and Capstone projects in the second and third semesters can be combined with elective internships in research institutes or companies. In the second and third semester, participation in additional public big data challenges is organized as an additional elective in the curriculum.

The Career Service Center (CSC) helps students in their career development. It provides students with high-quality training and coaching in CV creation, cover letter formulation, interview preparation, effective presenting, business etiquette, and employer research as well as in many other aspects, thus helping students identify and follow up on rewarding careers after graduating from Constructor University. For further information, please contact the Career Service Center (CSC) (https://constructor.university/student-life/career-services). Furthermore, the Alumni Office helps students establish a long-lasting and global network which is useful when exploring job options in academia, industry, and elsewhere.

1.6 Admission Requirements

Admission to Constructor University is selective and based on a candidate's university achievements, recommendations and self-presentation. Students admitted to Constructor University demonstrate exceptional academic achievements, intellectual creativity, and the desire and motivation to make a difference in the world.

The following documents need to be submitted with the application:

- Letter of motivation
- Curriculum vitae (CV)
- Official or certified copies of university transcripts
- Bachelor's degree certificate or equivalent
- Language proficiency test results (minimum score of 90 (TOEFL), 6.5 (IELTS) or 110 (Duolingo)).
- Copy of Passport
- Letter of recommendation (optional).

Formal admission requirements are subject to higher education law and are outlined in the Admission and Enrollment Policy of Constructor University.

For more detailed information about the admission visit:
Application Information | Constructor University

1.7 More information and contacts

For more information on the study program please contact the Study Program Coordinator:

Prof. Dr. Hilke Brockmann

Professor of Sociology

Email: hbrockmann@constructor.university

or visit our program website: Data Science for Society and Business | Constructor University

For more information on Student Services please visit:

https://constructor.university/student-life/student-services

2 The Curriculum

2.1 The Curriculum at a Glance

The DSSB MSc program is composed of foundational lectures, specialized modules, interactive seminars, tutorials, and applied project work. These lead to a master thesis that can be conducted in close collaboration with research, institutional, or industry partners, on or even off-campus, that is, at a partner university, a political organization, or a company site. The program takes four semesters (two years). The following table provides an overview of the program's modular structure. The program is partitioned into five areas (core, elective, methods, discovery, and career) and the master thesis. All credit points (CP) are based on ECTS. Students need to obtain a total of 120 CP to graduate.

2.2 Schematic Study Scheme

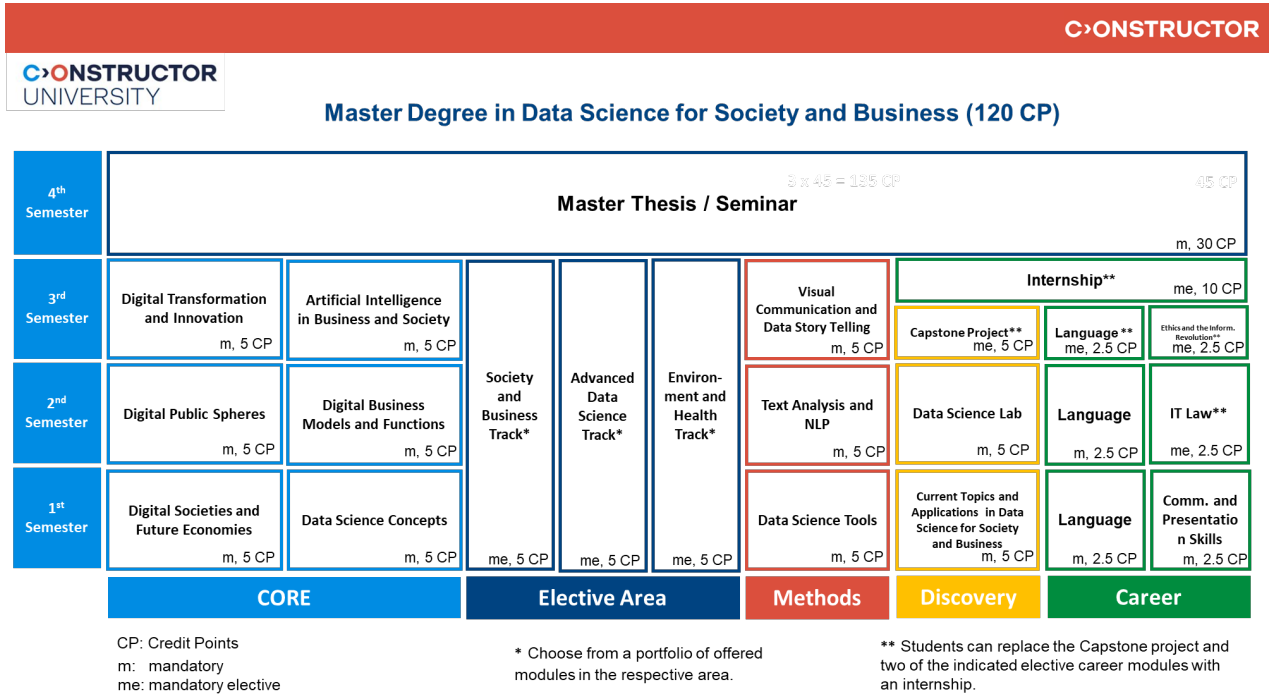

Figure 1: Schematic Study Scheme for DSSB (120 CP)

2.3 Study and Examination Plan

MSc Degree in Data Science for Society and Business Matriculation Fall 2023							
Module Code	**Program-Specific Modules**	**Type**	**Assessment**	**Period**	**Status[1]**	**Semester**	**CP**
Semester 1							**30**
	CORE Area						**10**
	Unit: Digital Societies						
MDSSB-DSOC-01	**Module: Digital Societies and Future Economies**				**m**	**1**	**5**
MDSSB-DSOC-01	Digital Societies and Future Economies	Lecture	Written examination	Examination period			
MDSSB-DSOC-02	**Module: Data Science Concepts**				**m**	**1**	**5**
MDSSB-DSOC-02	Data Science Concepts	Lecture/Tutorial	Written examination	Examination period			
	Elective Area						**5**
	- students choose one module from those listed below						
	Methods Area						**5**
MDSSB-MET-01	**Module: Data Science Tools**				**m**	**1**	**5**
MDSSB-MET-01-A	Data Science Tools in R	Lecture/Tutorial	Project report	Examination period			2.5
MDSSB-MET-01-B	Data Science Tools in Python	Lecture/Tutorial					2.5
	Discovery						**5**
MDSSB-APP-01	**Module: Current Topics and Applications in Data Science**				**m**	**1**	**5**
MDSSB-APP-01	Current Topics and Applications in Data Science	Lecture	Project report	Examination period			
	CAREER						**5**
MCA006	**Module: Communication and Presentation Skills**				**m**	**1**	**2.5**
MCA006-051464	Communication and Presentation Skills	Seminar	Oral presentation	During semester			
CTLA-	**Module: Language 1**				**m**	**1**	**2.5**
	German is the default language. Native German speakers take modules in another offered language.						
CTLA-	Language 1	Seminar	Various	Various	me		
Semester 2							**30**
	CORE Area						**10**
	Unit: Digital Transformation in Business						
MDSSB-DTRANS-01	**Module: Digital Public Spheres**				**m**	**2**	**5**
MDSSB-DSOC-01	Digital Public Spheres	Seminar	Term paper	Examination period			
MDSSB-DTRANS-02	**Module: Digital Business Models & Functions**				**m**	**2**	**5**
MDSSB-DSOC-02	Digital Business Models and Functions	Lecture	Term paper	Examination period			
	Elective Area						**5**
	- Students choose a module from those listed below.						
	Methods Area						**5**
MDSSB-MET-02	**Module: Text Analysis and Natural Language Processing**				**m**	**2**	**5**
MDSSB-MET-02	Text Analysis and Natural Language Processing	Seminar/Lab	Project report	Examination period			
	Discovery						**5**
MDSSB-DSCI-01	**Module: Data Science Lab**				**m**	**2**	**5**
MDSSB-DSCI-01	Data Science Lab	Lab	Project Assessment	Examination period			
	CAREER						**5/2.5**
MDSSB-EIR-01	**Module: IT-Law**				**me***	**2**	**2.5**
MDSSB-LAW-01	IT-Law	Lecture	Term Paper	Examination period			
CTLA-	**Module: Language 2**				**m**	**2**	**2.5**
CTLA-	Language 2	Seminar	Various	Various	me		
Semester 3							**30**
	CORE Area						**10**
	Unit: Data Science and Artificial Intelligence Concepts						
MDSSB-DSAI-01	**Module: Digital Transformation and Innovation**				**m**	**3**	**5**
MDSSB-DSAI-01-A	Digital transformation of organizations	Seminar	Term paper	Examination period			2.5
MDSSB-DSAI-01-B	Digital services and innovation	Seminar					2.5
MDSSB-DSAI-02	**Module: Artificial Intelligence in Business & Society**				**m**	**3**	**5**
	Artificial Intelligence in Business and Society	Lecture/Lab	Project report	During semester			
	Elective Area						**5**
	- students choose one module from those listed below						
	Methods Area						**5**
MDSSB-MET-03	**Module: Visual Communication and Data Story Telling**				**m**	**3**	**5**
MDSSB-MET-03	Visual Communication and Data Story Telling	Lecture/Tutorial	Project report	During semester			
	Discovery						**5/0**
MDSSB-CAP-01	**Module: Capstone Project**				**me***	**3**	**5**
MDSSB-CAP-01	Capstone Project	Seminar	Project report	During semester			
	CAREER						**5/12.5**
MDSSB-EIR-01	**Module: Ethics and the Information Revolution**				**me***	**3**	**2.5**
MDSSB-EIR-01	The Information Revolution	Seminar	Term paper	Examination period			2.5
CTLA-	**Module: Language 3**				**me***	**3**	**2.5**
CTLA-	Language 3	Seminar	Various	Various			
MDSSB-INT-01	**Module: Internship**				**me***	**3**	**10**
MDSSB-INT-01	Internship	Internship/Project	Report	Examination period			
Semester 4							**30**
MDSSB-THE-01	**Master Thesis**						**30**
MDSSB-THE-01	**Module: Master Thesis DSSB**				**m**	**4**	**30**
MDSSB-THE-01	Master Thesis						
Total CP							**120**
1m = mandatory, me = mandatory elective							
* Students can replace the Capstone project, and two of the indicated career modules with an internship. See 3.5.5 in the handbook.							

Elective Area							
Students choose 15 CP of manadatory electives							
	Society and Business Track						**25**
MDSSB-SOCB-01	**Module: Cybercriminology**				**me**	**1 or 3**	**5**
MDSSB-SOCB-01	Cybercriminology	Seminar	Term paper	Examination period			
MDSSB-SOCB-02	**Module: Introduction to Computational Social Science**				**me**	**2**	**5**
MDSSB-SOCB-02	Computational Social Science	Seminar	Term paper	Examination period			
MSCM-CO-08	**Module: Smart Cities and Transport Concepts**				**me**	**1 or 3**	**5**
MSCM-CO-08	Smart Cities and Transport Concepts	Lecture	Project report	Examination period			
MDSSB-ECON-01	**Module: Sustainability Economics**				**me**	**1 or 3**	**5**
MDSSB-ECON-01	Sustainability Economics	Seminar	Presentation / term paper	Examination period / during semester			
MSCM-CO-09	**Module: Principles of Consulting**				**me**	**1 or 3**	**5**
MSCM-CO-09	Principles of Consulting	Lecture/Seminar	Project Report	Examination period			
	Advanced Data Science Track						**20**
MDE-CO-02	**Module: Data Analyitcs**				**me**	**1 or 3**	**5**
MDE-CO-02	Data Analyitcs	Lecture/Tutorials	Written examination	Examination period			
MDE-BSC-01	**Module: Data Mining**				**me**	**2**	**5**
MDE-BSC-01	Data Mining	Lecture	Project report	Examination period			
MDE-CO-04	**Module: Machine Learning**				**me**	**2**	**5**
MDE-CO-04	Machine Learning	Lecture	Written examination	Examination period			
MDE-MET-03	**Module: Introduction to Data Management with Python**				**me**	**3**	**5**
MDE-MET-03-A	Introduction to Data Management with Python - Lecture	Lecture	Written examination	Examination period			2.5
MDE-MET-03-B	Introduction to Data Management with Python - Tutorial	Tutorial	Programming assignments	During semester			2.5
	Environment and Health Track						**20**
MEGI001	**Module: Geo-Informatics**				**me**	**1**	**5**
MEGI001-210213	Geo-Information Systems	Lecture	Term paper	Examination period	m		2.5
MEGI001-210103	Introduction to Eath and System Data	Lecture			m		2.5
MEGI002-GeoInfLab	**Module: Geo Informatics Lab**				**me**	**2**	**5**
MEGI002-210214	Geo Informatics Lab	Lecture	Term paper	Term paper			
MEBI003-ModCompSys	**Module: Modeling and Analysis of Complex Systems**				**me**	**1 or 3**	**5**
MEBI003-550453	Modeling and Analysis of Complex Systems	Lecture	Written examination	Examination period			
MMM007-NetBioMed	**Module: Network Approaches in Biology and Medicine**				**me**	**1 or 3**	**5**
MMM007-550443	Network Approaches in Biology and Medicine	Lecture	Presentations	During semester			
Total CP							

Figure 2: Study and Examination Plan

2.4 Core Area

Core modules describe and analyze the machine-social context, along with the changes and challenges imposed by new information technologies on today's and future firms, entire economies, and societies. They also teach students data science approaches, new models, and analytical techniques. Hence, we aim at three units consisting of two 5-CP modules for research on digitization and societies (10 CP), digital transformation in business (10 CP), and data science and AI concepts (10 CP).

To pursue an DSSB master, the following CORE modules (30 CP) need to be taken as mandatory modules (m):

- CORE Module: Digital Societies and Future Economics (m, 5 CP)
- CORE Module: Data Science Concepts (m, 5 CP)
- CORE Module: Digital Public Spheres (m, 5 CP)
- CORE Module: Digital Business Models and Functions (m, 5 CP)
- CORE Module: Artificial Intelligence in Business and Society (m, 5 CP)
- CORE Module: Digital Transformation and Innovation (m, 5 CP)

2.5 Methods Area

Methods modules are important in data science. Programming skills, innovative and dynamic models, experimental methods, and up-to-date software are essential for understanding, replicating, and contributing to research.

To pursue a DSSB master, the following Methods modules (15 CP) need to be taken as mandatory modules (m):

- Methods Module: Data Science Tools (m, 5 CP)
- Methods Module: Text Analysis and Natural Language Processing (m, 5 CP)
- Methods Module: Visual Communication and Data Story-telling (m, 5 CP)

2.6 Discovery Area

Discovery modules engage students in diverse applications. Faculty from different disciplines introduce up-to-date data science applications. Experts from business, public administration, and other organizations reveal their digital data needs and solutions. These diverse experiences and insights lead to innovative experimentation in a data science lab and culminate in an individual Capstone project in which students bring their theoretical and practical expertise together to creatively answer pressing social and data science problems, such as in health education, social media marketing, robotics, data security, or digital government. Students who prefer to complete an internship with a company or public organization can exchange the Capstone project and two mandatory elective career modules for this off-campus learning experience.

To pursue a DSSB master without an internship, the following Discovery modules (15 CP) need to be taken as mandatory modules (m):

- Discovery Module: Current Topics and Applications in Data Science (m, 5 CP)
- Discovery Module: Data Science Lab (m, 5 CP)
- Discovery Module: Capstone Project (me, 5 CP)

2.7 Career Area

Modules in the career area aim to broaden the intellectual skills of students and boost their employability. Language modules and seminars on ethical and legal questions help in understanding people with different cultural backgrounds and normative concerns about the digitalization of our society. Targeted modules on communication and career skills directly support students to exchange and function well in professional environments. Students who prefer to complete an internship with a company or public organization can exchange the Capstone project and two mandatory elective career modules for this off-campus learning experience.

To pursue a DSSB master, the following Career modules (7.5 CP) need to be taken as mandatory modules (m):

- Career Module: Language Skills I (m, 2.5 CP)
- Career Module: Communication and Presentation Skills (m, 2.5 CP)
- Career Module: Language Skills II (m, 2.5 CP)

The remaining Career modules (7.5 CP) can be selected according to interest from the mandatory elective modules (me):

- Career Module: IT Law* (me, 2.5 CP)
- Career Module: Ethics and the Information Revolution* (me, 2,5 CP)
- Career Module: Language Skills III* (me, 2,5 CP)
- Career Module: Internship* (me, 10 CP)

* Students can replace the Capstone project, and two of the indicated career modules with an internship. See 3.5.5 in the handbook.

2.7.1 Mandatory Elective Internship

A mandatory elective, 6-week full-occupation internship (or an equivalent part-time arrangement) gives students the opportunity to train, foster, and apply their acquired skills in data handling, data analytics, and data interpretation activities in a professional setting. It helps them further develop employer-valued skills, such as teamwork, effective communication, steadiness, diligence, and attention to detail. Students engage with the corporate world, learn how to cope and excel in a new environment, and can prepare an application-oriented master thesis, which may facilitate their entry to the job market.
The internship content must be relevant to data science. Task specifications need to be appropriate for a master's level student. The module coordinator and the Career Service Center will support students in finding suitable positions. The module coordinator also decides on the professional eligibility of the internship. Submission of an internship work program is recommended prior to starting the internship.

The internship of 10 CP that will usually be completed during the summer break between the second and third semester of study replaces the Capstone project and two of the three career modules in IT Law, Language III, and Ethics and Information Revolution.

2.8 Elective Area

Electives allow students to expand and connect their expertise with other subjects. Business, computer science, criminology, spatial sciences, public health, and supply chain management modules also allow specialization. The DSSB graduate program attracts students with diverse career goals, backgrounds, and prior work experience. Students can choose to strengthen their knowledge by focusing on one of the following three areas: Society and Business, Data Science, or Environment and Health. The Advanced Data Science track provides a deeper insight into the general application and technical details of data management along with analysis algorithms and techniques. The modules in this track require profound mathematical and computing knowledge. The Society and Business track offers an insight into a broader portfolio of data science applications in sociology and economics. The Environment and Health track addresses the handling and analysis of environmental and health data with specific structures, such as spatial data or network data. These are recommended focus tracks. Students may, however, choose any combination of the non-mandatory modules listed below.

To pursue an DSSB master, students choose the following Electives modules (15 CP) as mandatory elective modules (me):

Society and Business Track:

- Electives Module: Cybercriminology I (me, 5 CP)
- Electives Module: Introduction to Computational Social Science (me, 5 CP)
- Electives Module: Smart Cities and Transport Concepts (me, 5 CP)
- Electives Module: Sustainability Economics (me, 5 CP)
- Electives Module: Principles of Consulting (me, 5 CP)

Advanced Data Science Track:

- Electives Module: Data Analytics (me, 5 CP)
- Electives Module: Data Mining (me, 5 CP)
- Electives Module: Machine Learning (me, 5 CP)
- Electives Module: Introduction to Data Management with Python (me, 5 CP)

Students wanting to select Data Mining need to take Data Analytics in the first semester.

Environment and Health Track:

- Electives Module: Geoinformatics (me, 5 CP)
- Electives Module: Geoinformatics Lab (me, 5 CP)
- Electives Module: Modeling and Analysis of Complex Systems (me, 5 CP)
- Electives Module: Network Approaches in Biology and Medicine (me, 5 CP)

Students wanting to select Geo Informatics Lab need to take Geoinformatics in the first semester.

3 Module Descriptions

3.1 Core Area

3.1.1 Digital Societies and Future Economies

<table>
<tr><td colspan="2">Module Name</td><td>Module Code</td><td>Level (type)</td><td>CP</td></tr>
<tr><td colspan="2">Digital Societies and Future Economies</td><td>MDSSB-DSOC-01</td><td>Year 1 (CORE)</td><td>5</td></tr>
<tr><td colspan="5">Module Components

Number | Name | Type | CP</td></tr>
<tr><td>MDSSB-DSOC-01</td><td colspan="2">Digital Societies and Future Economies</td><td>Lecture</td><td>5</td></tr>
<tr><td>Module Coordinator

Prof. Dr. Hilke Brockmann</td><td colspan="2">Program Affiliation

• MSc Data Science for Society and Business (DSSB)</td><td colspan="2">Mandatory Status

Mandatory for DSSB</td></tr>
<tr><td colspan="2">Entry Requirements

Pre-requisites

☒ None

Co-requisites Knowledge, Abilities, or Skills

☒ None</td><td>Frequency

Annually (Fall)

Duration

1 Semester</td><td colspan="2">Forms of Learning and Teaching)

• Lecture (35 h)
• Reading Classes (17.5 h)
• Private Study (72.5 h)

Workload

125 h</td></tr>
<tr><td colspan="5">Recommendations for Preparation

• Martin Kenney (Ed) (2000) Understanding Silicon Valley. The Anatomy of an Entrepreneurial Region. Stanford University Press. Stanford.
• OECD (2019) Measuring the Digital Transformation. A Roadmap to the Future. OECD Publishing. Paris.</td></tr>
<tr><td colspan="5">Content and Educational Aims

What institutional, scientific, economic, political, and social constellations procured the development and success of digital technologies? Who are the major agents in the IT revolution? And what consequences will future people, economies, political regimes, and societies face from ongoing digital innovations? During this introductory lecture, students learn in depth about digital technologies, their economy, as well as their legal, political, and social context and future impact. Starting with the rise of Silicon Valley, the module shows how the clustering of political will, research money, university trained resources, venture capital, and expanding intellectual property rights enabled people to innovate, start new businesses, and eventually become rich. We will then take stock of the contemporary digital technologies, and analyze how they shape today's economy, power structures, and social processes around the globe. The last part of the lecture will focus on the predicted and simulated outcomes of the next wave of digital innovations, particularly on the effect of AI, quantum computing, and other digital innovations on future societies and our planet.

Topics

• the history of digital innovation
• the specifics of digital and communication technologies
• the digital networked economy and its legal framework
• digital politics - chances and threats
• networked elites</td></tr>
</table>

- from the digital divide to digital social mobility
- prediction, simulation, and discussions on the effects of digital innovations on future capitalism, democracy, consumption, and the planet

Intended Learning Outcomes

By the end of this module, students will be able to

1. know, understand, and assess the major concepts and social determinants of technological progress, digital progress in particular, and the concept of digital technologies as "general purpose technologies"
2. explain and evaluate the social, military, economic, and political context of technological innovation
3. comprehend and critically assess the political economy and business models of the IT industry
4. know and discuss the most important IT regulations in the EU, US, and developing countries
5. analyze and judge digital politics from an international perspective
6. identify, comprehend, and develop solutions for the social "digital divide"
7. explain, compare, and predict the disruptive consequences of digital innovations, particularly the impact of AI on people's life and social institutions

Indicative Literature

None.

Usability and Relationship to other Modules

This module lays the groundwork for the study and a deeper understanding of the causes and consequences of digital transformation of contemporary societies. It connects to the studies on digital public spheres, digital economies, and disruptive social changes, and inspires students to develop their own projects in the discovery field.

Examination Type: Module Examination

Assessment Type: Written Examination — Duration: 120 min
Weight: 100%

Scope: All intended learning outcomes of the module.
Completion: to pass this module, the examination has to be passed with at least 45%.

3.1.2 Data Science Concepts

<table>
<tr><td colspan="2">Module Name
Data Science Concepts</td><td>Module Code
MDSSB-DSOC-02</td><td>Level (type)
Year 1 (CORE)</td><td>CP
5</td></tr>
<tr><td colspan="5">Module Components

Number | Name | Type | CP
MDSSB-DSOC-02 | Data Science Concepts | Lecture/Tutorial | 5</td></tr>
<tr><td>Module Coordinator

Prof. Dr. Adalbert F. X. Wilhelm / Prof. Dr. Jan Lorenz</td><td colspan="2">Program Affiliation

• MSc Data Science for Society and Business (DSSB)</td><td colspan="2">Mandatory Status

Mandatory for DSSB</td></tr>
<tr><td colspan="2">Entry Requirements

Pre-requisites: ☒ None
Co-requisites: • Data Science Tools
Knowledge, Abilities, or Skills</td><td>Frequency

Annually (Fall)

Duration

1 semester</td><td colspan="2">Forms of Learning and Teaching

• Lecture (35 hours)
• Tutorial (17.5 hours)
• Private study (72.5 hours)

Workload

125 hours</td></tr>
<tr><td colspan="5">Recommendations for Preparation

Partake in the free online course “Data Science 101”.</td></tr>
<tr><td colspan="5">Content and Educational Aims

Data science is currently one of the hottest fields in the job market, and combines concepts and techniques from various fields, in particular computer science and statistics. This module combines the mathematical and statistical foundations with the major algorithmic concepts of data science. The module introduces the fundamental principles of linear algebra for data analysis and gives special attention to dimension reduction techniques and other data projection algorithms. It covers the fundamental probability concepts needed for assessing and evaluating modeling results and predictions, and proceeds to discuss complexity issues for data science projects. The second part of the module overviews supervised and unsupervised learning techniques.
This module aims at providing the fundamental knowledge in mathematics and statistics necessary for understanding the practical application of data science algorithms and evaluating their performance. It also provides an overview of the fundamental concepts along with the main questions and approaches in data science.
Students will learn how to address societal and business-related issues based on practically relevant questions, digital data, and their learned programming and analytical skills from synchronized methods modules.</td></tr>
<tr><td colspan="5">Intended Learning Outcomes

Upon the completion of this module, students will be able to
1. understand and use the mathematical foundations of statistical learning algorithms
2. explain and classify data science problems
3. explain and classify data-driven approaches
4. understand the application of data science techniques to typical situations and tasks in business and societal research, including the search, retrieval, preparation, and statistical analysis of data
5. interpret complexity analysis and performance evaluation of data science problems and algorithms</td></tr>
</table>

Indicative Literature

Kotu, Deshpande (2019) Data Science: Concepts and Practice. Cambridge, MA: Morgan Kaufman, Elsevier.

Bruce, Bruce, Gedeck (2020) Practical Statistics for Data Scientists. 50+ Essential Concepts Using R and Python. Sebastopol, CA: O-Reilley.

Usability and Relationship to other Modules

This module creates the foundation for all data science related modules in the program. Practical applications of approaches studied in this module will be performed in the Data Science Tools module.

Examination Type: Module Examination

Assessment Type: Written Examination — Duration: 120 min
Weight: 100%

Scope: All intended learning outcomes of the module.
Completion: to pass this module, the examination has to be passed with at least 45%.

3.1.3 Digital Public Spheres

<table>
<tr><td colspan="3">Module Name

Digital Public Spheres</td><td>Module Code

MDSSB-DTRANS-01</td><td>Level (type)

Year 1 (CORE)</td><td>CP

5</td></tr>
<tr><td colspan="6">Module Components

Number | Name | Type | CP
MDSSB-DTRANS-01 | Digital Public Spheres | Seminar | 5</td></tr>
<tr><td colspan="2">Module Coordinator

Prof. Dr. Hilke Brockmann</td><td colspan="2">Program Affiliation

• MSc Data Science for Society and Business (DSSB)</td><td colspan="2">Mandatory Status

Mandatory for DSSB</td></tr>
<tr><td colspan="3">Entry Requirements

Pre-requisites
• Digital Societies and Digital Futures
• Data Science Tools
• Data Science Concepts

Co-requisites
☒ None

Knowledge, Abilities, or Skills
• Basic R Programming Knowledge</td><td>Frequency

Annually (Spring)

Duration

1 Semester</td><td colspan="2">Forms of Learning and Teaching

• Seminar (35 h)
• Team project (50 h)
• Self-study (online and offline 40 h)

Workload

125 h</td></tr>
<tr><td colspan="6">Recommendations for Preparation

• Schäfer (2015) Digital Public Sphere. In: Mazzoleni et al. (Eds.) The International Encyclopedia in Political Communication. London. Pp. 322-328.
• Shaw, Hargittai (2018) The Pipeline of Online Participation Inequalities: The Case of Wikipedia Editing. Journal of Communication 68:143-168.</td></tr>
<tr><td colspan="6">Content and Educational Aims

Digital communication platforms change the way people communicate, select information, and form opinions. Are they threatening democracies which rely on freedom of speech? Are digital technologies supporting authoritarian regimes as they allow for massive real-time surveillance? Or are they gateways for new actors and a more diverse political audience to interact closely and revive political discourse and mobilization? This module interrogates if and how digital technologies have and will alter public spheres by referring to both theoretical concepts of the public sphere and empirical studies. Simulated and predicted future scenarios will be critically assessed.

Topics:

• Political Regimes and the “Old” Public Sphere
• Republic 2.0—The Ambivalent Promises of the Digital Public Sphere
• Country Cases
• Digital Technologies and Public Mobilization
• State Surveillance
• The Power of Tech Firms and Republic.com
• Simulated Futures of the Public Sphere</td></tr>
<tr><td colspan="6">Intended Learning Outcomes

By the end of this module, students will be able to

1. demonstrate a profound knowledge of the state-of-the-art theories and empirical findings on digital public spheres
2. use research tools to study and assess the qualities of digital public spheres</td></tr>
</table>

3. critically question the functionality of digital media as surveillance technologies and their use by state and non-state actors
4. evaluate and design case studies
5. forecast future scenarios

Indicative Literature

Schäfer (2015) Digital Public Sphere. In: Mazzoleni et al. (Eds.) The International Encyclopedia in Political Communication. London. Pp. 322-328.
Shaw, Hargittai (2018) The Pipeline of Online Participation Inequalities: The Case of Wikipedia Editing. Journal of Communication 68:143-168.

Usability and Relationship to other Modules

This module sheds light on the political dimension of digitization. It bridges disciplinary research gaps and provides a better understanding of business, economic, sociological, legal, and ethical modules.

Examination Type: Module Examination

Assessment Type: Term Paper — Length: 4000 – 5000 words
Weight: 100%

Scope: All intended learning outcomes of the module.
Completion: to pass this module, the examination has to be passed with at least 45%.

3.1.4 Digital Business Models and Functions

<table>
<tr><td colspan="3">Module Name

Digital Business Models and Functions</td><td>Module Code

MDSSB-DTRANS-02</td><td>Level (type)

Year 1 (CORE)</td><td>CP

5</td></tr>
<tr><td colspan="6">Module Components

Number | Name | Type | CP
MDSSB-DTRANS-02 | Digital Business Models and Functions | Lecture | 5</td></tr>
<tr><td>Module Coordinator

Prof. Dr. Tilo Halaszovich</td><td colspan="3">Program Affiliation

• MSc Data Science for Society and Business (DSSB)</td><td colspan="2">Mandatory Status

Mandatory for DSSB</td></tr>
<tr><td colspan="3">Entry Requirements

Pre-requisites: ☒ none
Co-requisites: ☒ None
Knowledge, Abilities, or Skills:
• Academic writing skills
• Good understanding of the principles of business functions</td><td>Frequency

Annually (Spring)

Duration

1 semester</td><td colspan="2">Forms of Learning and Teaching

• Lecture (35 hours)
• Private studies on cases (30 hours)
• Private studies on content (60 hours)

Workload

125 hours</td></tr>
<tr><td colspan="6">Recommendations for Preparation

None.</td></tr>
<tr><td colspan="6">Content and Educational Aims

Businesses today have just begun to understand the potential of data abundance. Companies such as Amazon and Google were among the pioneers of data-driven business models. Many technology-based start-ups are eager to follow their lead. The data-driven revolution in the business world is nothing less than what Schumpeter termed a process of creative destruction. In this case, the destruction is of the long-established ways of doing business. The representatives of this new-age alternative business models range from shared economies and platform businesses to subscription models, even in the most traditional industries.

In this module, we will uncover the antecedents, drivers, and potentials of a data-driven economy by focusing on entrepreneurs and how their experiments creatively destruct the way we used to do business. We will explain why e-commerce is the fastest growing segment in retail today. We will examine e-commerce business models, technology infrastructure, e-commerce marketing and advertising concepts, social networks, auctions, and portals, as well as ethical, social, and political issues with the help of prominent case studies. At the end of the module, students will be able to build their own e-commerce (small-scale) companies.</td></tr>
<tr><td colspan="6">Intended Learning Outcomes

By the end of this module, students will be able to
1. know about the development of business models on the Internet
2. conceptually understand how to build an e-commerce presence
3. comprehensively understand e-commerce security and payment systems
4. critically understand e-commerce marketing and advertising
5. discuss and reflect on major obstacles and possible solutions in e-commerce ethics
6. critically evaluate and design business case studies</td></tr>
<tr><td colspan="6">Indicative Literature</td></tr>
</table>

Zott, Amit (2017) Business Model Innovation: How to Create Value in a Digital World. Marketing Intelligence Review 9 (1) DOI: https://doi.org/10.1515/gfkmir-2017-0003

Wirtz (2019) Digital Business Models: Concepts, Models, and the Alphabet Case Study. Cham: Springer Nature.

Usability and Relationship to other Modules

This module focuses on digital business concepts and digital business models. It connects to all business modules in the "Society and Business" track to the core "Digital Transformation and Innovation" and "Artificial Intelligence in Business and Society" modules. However, it also forms the base for students who want to develop their own business ideas in the discovery section of the program and outside academia.

Examination Type: Module Examination

Assessment Type: Term Paper Length: 5000 words
Weight: 100%

Scope: All intended learning outcomes of the module.
Completion: to pass this module, the examination has to be passed with at least 45%.

3.1.5 Digital Transformation and Innovation

Module Name			**Module Code**	**Level (type)**	**CP**
Digital Transformation and Innovation			MDSSB-DSAI-01	Year 2 (CORE)	5

Module Components

Number	Name	Type	CP
MDSSB-DSAI-01-A	Digital Transformation of Organizations	Seminar	2.5
MDSSB-DSAI-01-B	Digital Services and Innovation	Seminar	2.5

Module Coordinator	**Program Affiliation**	**Mandatory Status**
Prof. Dr. Christoph Lattemann	• MSc Data Science for Society and Business (DSSB)	Mandatory for DSSB

Entry Requirements			**Frequency**	**Forms of Learning and Teaching**
Pre-requisites	Co-requisites	Knowledge, Abilities, or Skills	Annually (Fall)	• Seminars (35 hours) • Private study (90 hours)
☒ None	☒ None	☒ None	**Duration**	**Workload**
			1 semester	125 hours

Recommendations for Preparation

Vargo, S. L., Lusch, R. F. (2004). Evolving to a new dominant logic for marketing. Journal of Marketing, 68(1): 1-17.

Content and Educational Aims

The goal of this module is to help students learn, understand, and practice data-driven innovation for customers and change processes at an individual and organizational level. This module helps students understand real-life challenges in a complex and digitized world with multiple stakeholder interests. Further, students learn to develop and present innovative user-centered and theory-oriented solutions for real-world challenges in an IT-driven world. This module is home to two seminars of 7 weeks each. The first seminar investigates the digital transformations of organizations. It prepares students to understand and manage organizational change and transformation processes against a digitalization background. In particular, the following topics are discussed: organizational and algorithmic decision making, change and inertia, automation and reliability, and data-driven blindspots. The second seminar looks into digital innovation and their users. This seminar is strongly based on the paradigm of user-centeredness, user-centered design, and the ideas of the service dominant logic—a meta-theoretical framework for explaining value co-creation through exchange among various configurations of actors.

Intended Learning Outcomes

Upon completion of this module, students will be able to

1. summarize and classify the new data- and customer-driven technologies in a business context
2. explain the economic and business rules in the information age
3. explain the pros and cons of reliance on data and automation in organizations
4. conduct independent analyses of organizations,' markets,' and users' needs using scientific methods
5. explain the service dominant logic (SDL) for business/entrepreneurial activities and the power of new technologies for customer relationship management
6. improve their oral communication, along with individual and group presentation skills

Indicative Literature

Vargo, S. L., Lusch, R. F. (2004). Evolving to a new dominant logic for marketing. Journal of Marketing, 68(1): 1-17.

Usability and Relationship to other Modules

This module teaches the impact of digital technologies on organizational change. Insights can be used in all modules, particularly in the core and elective business and society modules, during the Capstone project and the internship.

Examination Type: Module Examination

Assessment Type: Term Paper	Length: 3000 words Weight: 100%

Scope: All intended learning outcomes of the module.

The module gives the opportunity to do an additional preparatory presentation during the class for personal feedback on one's own performance in front of an audience. This additional presentation is voluntary that can improve the grade by 0.33 points (German grading system), but is not necessary to reach the best grade in the module (1.0).

Completion: to pass this module, the examination has to be passed with at least 45%.

3.1.6 Artificial Intelligence in Business and Society

<table>
<tr><td colspan="3">Module Name
Artificial Intelligence in Business and Society</td><td>Module Code
MDSSB-DSAI-02</td><td>Level (type)
Year 2 (CORE)</td><td>CP
5</td></tr>
<tr><td colspan="6">Module Components

Number | Name | Type | CP
MDSSB-DSAI-02 | Artificial Intelligence in Business and Society | Lecture/Lab | 5</td></tr>
<tr><td>Module Coordinator

Prof. Dr. Adalbert F.X. Wilhelm</td><td colspan="3">Program Affiliation

• MSc Data Science for Society and Business (DSSB)</td><td colspan="2">Mandatory Status

Mandatory for DSSB</td></tr>
<tr><td colspan="3">Entry Requirements

Pre-requisites | Co-requisites | Knowledge, Abilities, or Skills
• Data Science Concepts
• Data Science Tools
☒ None
• Profound knowledge in R</td><td>Frequency

Annually (Fall)

Duration

1 semester</td><td colspan="2">Forms of Learning and Teaching

• Lecture/Lab (35 hours)
• Private study (90 hours)

Workload

125 hours</td></tr>
<tr><td colspan="6">Recommendations for Preparation

Harvard Business Review (2019) Artificial Intelligence. HBSP: Boston, MA.</td></tr>
<tr><td colspan="6">Content and Educational Aims

AI is one of the current key words that instills hopes for reshaping economies by promising to generate productivity gains, improve efficiency, and contribute to better lives. At the same time, AI is also fueling anxieties and ethical concerns about codifying and reinforcing existing biases and infringing human rights, along with exacerbating inequality, climate change, market concentration, and the digital divide. This module will give a historical overview of AI's evolution, from the development of symbolic AI in the 1950s to the recent achievements in machine learning. It will introduce the basic AI principles and algorithms applied to common problems, including search, optimization, planning, and pattern recognition. The module will discuss the economic landscape of AI and its role as a new general-purpose technology that can lower the cost of prediction and enable better decisions, hence resulting in cost savings and enabling better resource allocation for a variety of applications, such as transport, agriculture, finance, marketing and advertising, science, health, criminal justice, security, the public sector, and augmented/virtual reality. The module will also review salient policy issues that accompany the diffusion of AI.
The objective of this module is to enhance students with the fundamental technical skills and knowledge to plan, design, develop, and evaluate AI applications from a business and a societal viewpoint. Upon successful completion of the module, students will not only have a profound knowledge on common techniques and areas of AI, including problem solving, knowledge representation, reasoning, decision making, planning, perception and action, and learning, but will also be able to understand the implementation of the key components of intelligent agents with a moderate complexity.</td></tr>
<tr><td colspan="6">Intended Learning Outcomes

Upon the completion of this module, students will be able to
1. understand key terms and components in AI approaches
2. explain key methods and techniques for automated decision making
3. understand implementations of key components of AI systems
4. evaluate the potentials and threats induced by AI systems
5. appraise AI application areas
6. discuss salient policy issues stirred by AI systems</td></tr>
<tr><td colspan="6">Indicative Literature

Agrawal, Gans, Goldfarb (2018) Prediction Machines. The Simple Economics of Artificial Intelligence. HBSP: Boston, MA</td></tr>
</table>

Cath, Wachter et al. (2017) Artificial Intelligence and the “Good Society”: The US, EU, and UK approach. Science and Engineering Ethics 24, 505-528.

Usability and Relationship to other Modules

This module uses insights from core and methods modules and can be applied to the Capstone project and the master thesis.

Examination Type: Module Examination

Assessment Type: Project Report — Length: 3000 words, Weight: 100%

Scope: All intended learning outcomes of the module.

Completion: to pass this module, the examination has to be passed with at least 45%.

3.2 Methods Area

3.2.1 Data Science Tools

<table>
<tr><td colspan="3">Module Name
Data Science Tools</td><td>Module Code
MDSSB-MET-01</td><td>Level (type)
Year 1 (METHODS)</td><td>CP
5</td></tr>
<tr><td colspan="6">Module Components

Number | Name | Type | CP
MDSSB-MET-01-A | Data Science Tools in R | Lecture/Tutorial | 2.5
MDSSB-MET-01-B | Data Science Tools in Python | Lecture/Tutorial | 2.5</td></tr>
<tr><td colspan="2">Module Coordinator

Prof. Dr. Adalbert F.X. Wilhelm / Prof. Dr. Jan Lorenz</td><td colspan="2">Program Affiliation

• MSc Data Science for Society and Business (DSSB)</td><td colspan="2">Mandatory Status

Mandatory for DSSB</td></tr>
<tr><td colspan="3">Entry Requirements

Pre-requisites: ☒ None
Co-requisites: ☒ Data Science Concepts
Knowledge, Abilities, or Skills</td><td>Frequency

Annually (Fall)

Duration

1 semester</td><td colspan="2">Forms of Learning and Teaching

• Lecture (17.5 hours)
• Tutorials (17.5 hours)
• Private study (90 hours)

Workload

125 hours</td></tr>
<tr><td colspan="6">Recommendations for Preparation

Partake in the free online course “Data Science 101”.</td></tr>
<tr><td colspan="6">Content and Educational Aims

Python and R are the most common programming languages in data science. Both Python and R build on vast software ecosystems and communities, and hence, can be used for tackling any data science task. While Python typically comes more intuitively to persons with a computer science or software development background, R allows them to be productive in a shorter time period without a programming background. This module is home to two tutorials of 7 weeks each. The first tutorial will focus on R and the second one on Python. Students will acquire fundamental programming skills in R and Python. They will explore various features of both programming languages and learn essential steps and commands for reading, converting, cleaning, storing, and transforming data to prepare it for statistical analyses. The module aims at providing an overview of the entire knowledge discovery process and will illustrate the predominant challenges and strategies through examples.</td></tr>
<tr><td colspan="6">Intended Learning Outcomes

By the end of this module, students will be able to
1. explain basic concepts of imperative and object-oriented programming
2. write, test, and debug programs
3. perform data handling and data manipulation tasks in R and Python
4. apply their knowledge to implement their own functions in R and Python
5. effectively use core packages and libraries of R and Python for data analysis
6. know about the typical applications of R and Python in data science
7. implement and apply advanced data mining methods with appropriate tools
8. perform a full cycle of data analysis</td></tr>
<tr><td colspan="6">Indicative Literature</td></tr>
</table>

Wickham, Grolemund (2017) R for Data Science: Import, Tidy, Transform, Visualize, and Model Data. Sebastopol, CA: O-Reilly.

VanderPlas (2016) Python Data Science Handbook: Essential Tools for Working with Data. Sebastopol, Ca: O'Reilly.

Usability and Relationship to other Modules

This module will put the theoretical and conceptual knowledge in "Data Science Concepts" into practice. It is the fundamental basis for modules in semester 2 and 3, particularly, the "Data Science Lab," "Data Analytics," and "Data Mining" modules.

Examination Type: Module Examination

Assessment Type: Project Report Length: 4000 - 5000 words
Weight: 100%

Scope: All intended learning outcomes of the module.

Module achievement: 50% of the assignments correctly solved.
This module introduces the R and Python programming languages. Students develop their imperative programming skills by solving data handling and data analysis problems. The module achievement ensures that a sufficient level of practical programming and problem-solving skills has been obtained.

In addition, students can use these assignments to improve their grade by 0.33 points (German grading system). although this is not necessary to reach the best grade in the module (1.0).
Completion: to pass this module, the examination has to be passed with at least 45%.

3.2.2 Text Analysis and Natural Language Processing

<table>
<tr><td colspan="3">Module Name

Text Analysis and Natural Language Processing</td><td>Module Code

MDSSB-MET-02</td><td>Level (type)

Year 1 (METHODS)</td><td>CP

5</td></tr>
<tr><td colspan="6">Module Components

Number | Name | Type | CP
MDSSB-MET-02 | Text Analysis and Natural Language Processing | Seminar/Lab | 5</td></tr>
<tr><td>Module Coordinator

Prof. Dr. Hilke Brockmann/ Prof. Dr. Jan Lorenz / Prof. Dr. Adalbert F.X. Wilhelm</td><td colspan="3">Program Affiliation

• MSc Data Science for Society and Business (DSSB)</td><td colspan="2">Mandatory Status

Mandatory for DSSB

Mandatory Elective for CSSE</td></tr>
<tr><td colspan="3">Entry Requirements

Pre-requisites: ☒ None
Co-requisites: ☒ None
Knowledge, Abilities, or Skills: ☒ Programming skills in R or Python at an intermediate level</td><td>Frequency

Annually (Spring)

Duration

1 semester</td><td colspan="2">Forms of Learning and Teaching

• Seminar (17.5 hours)
• Lab sessions (17.5 hours)
• Private Study (90 hours)

Workload

125 hours</td></tr>
<tr><td colspan="6">Recommendations for Preparation

None.</td></tr>
<tr><td colspan="6">Content and Educational Aims

This module will teach the fundamentals of text mining, natural language processing, and automated content analysis using R. Students will learn the entire text analysis pipeline, from basic web scraping techniques for collecting text data from social media, over text representations and ontologies, to text mining algorithms and efficient representation of analysis results. Students will be exposed to theoretical and methodological foundations of text mining, such as word frequencies, ontologies, bag-of-word, as well as the application of machine learning algorithms for text and sentiment analysis. The module will introduce exemplary studies on text and sentiment analysis and provide an opportunity for hands-on programming to realize different analyses. The module covers a spectrum of text mining methods, from basic lexicographic measures to more complex statistical learning algorithms such as sentiment analysis and topic modeling.</td></tr>
<tr><td colspan="6">Intended Learning Outcomes

By the end of this module, students will be able to
1. explain the concept of “text as data”
2. use basic methods for information extraction and text data retrieval
3. process and prepare text data for statistical modeling and automated content analysis
4. perform different text analyses using text mining packages in R
5. interpret diverse text analytical measures
6. undertake a knowledgeable automated content analysis with text data</td></tr>
<tr><td colspan="6">Indicative Literature</td></tr>
</table>

Silge, Robinson (2017) Text Mining with R: A Tidy Approach. Sebastopol, CA: O'Reilly

Usability and Relationship to other Modules

This module translates the insights from "Data Science Concepts" into text analysis. The module lays the basis for core and elective modules in semester 2 and 3, particularly for the "Digital Public Spheres," "Data Science Lab," "Data Analytics," and "Cybercriminology" modules.

Examination Type: Module Examination

Assessment Type: Project Report

Length: 3000 words
Weight: 100%

Scope: All intended learning outcomes of the module.
Completion: to pass this module, the examination has to be passed with at least 45%.

3.2.3 Visual Communication and Data Story-telling

<table>
<tr><td colspan="3">Module Name

Visual Communication and Data Story-telling</td><td>Module Code

MDSSB-MET-03</td><td>Level (type)

Year 2 (METHODS)</td><td>CP

5</td></tr>
<tr><td colspan="6">Module Components

Number | Name | Type | CP
MDSSB-MET-03 | Visual Communication and Data Story-telling | Lecture/Tutorial | 5</td></tr>
<tr><td>Module Coordinator

Prof. Dr. Jan Lorenz / Prof. Dr. Adalbert F.X. Wilhelm</td><td colspan="3">Program Affiliation

• MSc Data Science for Society and Business (DSSB)</td><td colspan="2">Mandatory Status

Mandatory for DSSB</td></tr>
<tr><td colspan="3">Entry Requirements

Pre-requisites
• Data Science Concepts
• Data Science Tools

Co-requisites
☒ None

Knowledge, Abilities, or Skills
☒ None</td><td>Frequency

Annually (Fall)

Duration

1 semester</td><td colspan="2">Forms of Learning and Teaching

• Lecture 17.5 hours
• Tutorials 17.5 hours
• Project work 90 hours

Workload

125 hours</td></tr>
<tr><td colspan="6">Recommendations for Preparation

Read the syllabus and search for appropriate online example cases.</td></tr>
<tr><td colspan="6">Content and Educational Aims

Data is often intuitively communicated using statistical graphs and visualization dashboards. Effective communication using visuals and dashboards has become a key qualification for modern business intelligence professionals. This module introduces the basic ideas and concepts of data visualization and data story-telling. Computer-based visualization systems provide visual representations of datasets to process data more effectively. These datasets may come from different sources, such as scientific experiments, simulations, medical scans, commercial databases, financial transactions, health records, and social networks. They also cater to different audiences. Students will learn about the theory of graphical design and the science of visual perception to make compelling visual representations with static and interactive maps for a scientific and non-scientific audience. Students learn to design elegant data visualizations that support the exchange of information and corroborate the data findings. Students also learn to evaluate visualization systems from both the designer's and audience's perspective. Visualization skills are further elaborated with the support of selected online programming snippets.

Topics:
● Theory of graphical design
● Grammar of graphics
● Science of visual perception
● Exploratory data analysis and static graphics in R
● Scientific story-telling for various formats and audiences
● Visualization programming</td></tr>
</table>

Intended Learning Outcomes

By the end of this module, students will be able to

1. visually represent various data sources
2. choose suitable visual representations for different data sets
3. evaluate visual depictions of data
4. assist users in visual data analysis
5. target visual representations to different audiences

Indicative Literature

Dykes (2019) Effective Data Storytelling: How to Drive Change with Data, Narrative, and Visuals. Hoboken, NJ: Wiley.

Nussbaumer, Knaflic (2015) Storytelling with Data: A Data Visualization Guide for Business Professionals. Hoboken, NJ: Wiley.

Usability and Relationship to other Modules

Can be used in all modules, particularly in the Capstone project and master thesis modules.

Examination Type: Module Examination

Assessment Type: Project Report	Length: 6000–8000 words Weight: 100%

Scope: All intended learning outcomes of the module.
Completion: to pass this module, the examination has to be passed with at least 45%.

3.3 Discovery Area

3.3.1 Current Topics and Applications in Data Science

<table>
<tr><td colspan="2">Module Name

Current Topics and Applications in Data Science</td><td>Module Code

MDSSB-APP-01</td><td>Level (type)

Year 1 (DISCOVERY)</td><td>CP

5</td></tr>
<tr><td colspan="5">Module Components

Number | Name | Type | CP
MDSSB-APP-01 | Current Topics and Applications in Data Science | Lecture | 5</td></tr>
<tr><td>Module Coordinator

Prof. Dr. Hilke Brockmann / Prof. Dr. Adalbert X. Wilhelm</td><td colspan="2">Program Affiliation

• MSc Data Science for Society and Business (DSSB)</td><td colspan="2">Mandatory Status

Mandatory for DSSB</td></tr>
<tr><td colspan="2">Entry Requirements

Pre-requisites: ☒ None
Co-requisites: • Data Science Concepts • Digital Societies and Future Economies • Data Science Tools
Knowledge, Abilities, or Skills: ☒ None</td><td>Frequency

Annually (Fall)

Duration

1 Semester</td><td colspan="2">Forms of Learning and Teaching

• Online and offline lecture (35 hours)
• Self-Study 90 hours

Workload

125 hours</td></tr>
<tr><td colspan="5">Recommendations for Preparation

Choose and take an appropriate online course such as the edX ETH Zürich Course on smart cities.</td></tr>
<tr><td colspan="5">Content and Educational Aims

This module focuses on cutting-edge research findings in data science (DS) and on today's and future applications. The objective is to connect basic research with solutions in business, politics, health, and other societal benefits. Throughout the module, scientific findings will be replicated and challenged with new problems and data. External experts will provide insights into today's applications in industry, service, research, and administrative sectors. They will also have discussions on the barriers and springboards for better future use. This module emphasizes on understanding and critically evaluating the research on DS and its real-world application. Students leave the module with a profound understanding of where and how products and services have spun and will spin off further research and better practical solutions.

Topics are
● Differences and Commonalities in Basic and Applied DS Research
● Big Data and Public Health
● Social Media and Social Mobilization Around the Globe
● Smart Cities
● Managing Planetary Boundaries with Spatial Data</td></tr>
</table>

- Scalability: Why is there only one Amazon?

Intended Learning Outcomes

By the end of this module, students will be able to

1. understand how core DS concepts, tools, and basic research can be applied to real-world problems
2. know major fields of DS applications
3. use their DS knowledge to identify practical problems and future applications
4. apply replication tools and techniques to try and simulate DS solutions
5. replicate a DS application

Indicative Literature

Yun et al. (2020) The Social Media Macroscope: A Science Gateway for Research using Social Media Data. Future Generation Computer Systems 111, 819-828

Latif et al. (2020) Leveraging Data Science to Combat Covid-19: A Comprehensive Review. Techrxiv.org

Usability and Relationship to other Modules

This module connects content from core Data Science modules with all discovery modules (Data Science Lab, Capstone Project). It may also link to modules from the elective tracks (depending on the selection of research topics).

Examination Type: Module Examination

Assessment Type: Project Report Length: 3000 words
Weight: 100%

Scope: All intended learning outcomes of the module.
Completion: to pass this module, the examination has to be passed with at least 45%.

3.3.2 Data Science Lab

<table>
<tr><td colspan="3">Module Name

Data Science Lab</td><td>Module Code

MDSSB-DSCI-01</td><td>Level (type)

Year 1
(DISCOVERY)</td><td>CP

5</td></tr>
<tr><td colspan="6">Module Components

Number | Name | Type | CP
MDSSB-DSCI-01 | Data Science Lab | Lab | 5</td></tr>
<tr><td colspan="2">Module Coordinator

N.N.</td><td colspan="2">Program Affiliation

• MSc Data Science for Society and Business (DSSB)</td><td colspan="2">Mandatory Status

Mandatory for DSSB</td></tr>
<tr><td colspan="3">Entry Requirements

Pre-requisites: • Data Science Concepts • Data Science Tools • Current Topics and Applications in Data Science
Co-requisites: ☒ None
Knowledge, Abilities, or Skills: ☒ None</td><td>Frequency

Annually
(Spring)

Duration

1 Semester</td><td colspan="2">Forms of Learning and Teaching

• Lab sessions (35 hours)
• Project (90 hours)

Workload

125 hours</td></tr>
<tr><td colspan="6">Recommendations for Preparation

None</td></tr>
<tr><td colspan="6">Content and Educational Aims

This module aims at providing students with an in-depth understanding and command over one of the social data science areas represented by the faculty research. The study topic (i.e., cognitive models and decision making; agent-based modeling of political processes, migration pattern, and happiness; networks and innovation diffusion) changes annually and from hosting group to hosting group. Lab sessions allow students to experiment with small research projects. Students learn how to identify relevant research questions, how to embed this into a larger framework of research, how to collect and use data, and how to apply computational components.</td></tr>
<tr><td colspan="6">Intended Learning Outcomes

By the end of this module, students should be able to
1. understand and critically evaluate current data science applications, identify new and innovative research questions and data science applications
2. experiment with and simulate data science solutions
3. write/configure computer programs/tools specific to certain subject areas
4. master relevant data pre/post-processing routines
5. design and schedule a DS project of medium complexity, including escape options, and keep milestones/timelines</td></tr>
</table>

6. improve their academic writing skills
7. communicate results to a non-expert audience
8. design their own digital application

Indicative Literature

Daniel (2019) Big Data and Data Science: A Critical Review of Issues for Educational Research. British Journal of Education Research 50(1), 101-113.

Usability and Relationship to other Modules

This module teaches students to translate content and skills into concrete project work. Its usability is high because applied skills are useful in any data science project. The lab module further connects to contextual and methodological modules depending on the self-selected focus.

Examination Type: Module Examination

Assessment Type: Project Assessment Weight: 100%

Scope: All intended learning outcomes of the module.
Completion: to pass this module, the examination has to be passed with at least 45%.

3.3.3 Capstone Project

<table>
<tr><td colspan="2">Module Name

Capstone Project</td><td>Module Code

MDSSB-CAP-01</td><td>Level (type)

Year 2 (DISCOVERY)</td><td>CP

5</td></tr>
<tr><td colspan="5">Module Components

Number | Name | Type | CP
MDSSB-CAP-01 | Capstone Project | Project | 5</td></tr>
<tr><td>Module Coordinator

Entire faculty (Prof. Dr. Hilke Brockmann)</td><td colspan="2">Program Affiliation

• MSc Data Science for Society and Business (DSSB)</td><td colspan="2">Mandatory Status

Mandatory for DSSB</td></tr>
<tr><td colspan="2">Entry Requirements

Pre-requisites | Co-requisites | Knowledge, Abilities, or Skills
• all mandatory core and methods modules of year 1 | ☒ None | ☒ None</td><td>Frequency

Annually (Fall)

Duration

1 semester</td><td colspan="2">Forms of Learning and Teaching

• Project work and individual consultations (125 hours)

Workload

125 hours</td></tr>
<tr><td colspan="5">Recommendations for Preparation

Train and advance programming skills with a pre-selected online course after a consultation with the instructor.</td></tr>
<tr><td colspan="5">Content and Educational Aims

The Capstone project enables students to merge their theoretical and applied knowledge to design an individual data science project. This project should originate from a close collaboration with researchers at the university and/or with data scientists in business firms or other institutions. Students learn how to integrate their data science expertise, study a question in depth, organize research in consecutive steps, report replicable research, and work on an applicable solution. Project outcomes will be presented to a larger audience and may be fed into a master thesis.</td></tr>
<tr><td colspan="5">Intended Learning Outcomes

By the end of this module, students will be able to
1. identify innovative research and applications
2. design and master a complex research project
3. schedule a research process, including escape options, and keep milestones/timelines
4. cooperate in a research team
5. improve academic writing skills
6. communicate results to a non-expert audience</td></tr>
<tr><td colspan="5">Indicative Literature

Iqbal et al. (2020) Big Data Analytic: Computational Intelligence Techniques and Application Areas. Technological Forecasting and Social Change 153: https://doi.org/10.1016/j.techfore.2018.03.024</td></tr>
</table>

Usability and Relationship to other Modules

This module lays the groundwork for the master thesis. It also provides an opportunity to use the acquired data science knowledge to solve a new problem. It relates to all modules from semesters 1–3.

Examination Type: Module Examination

Assessment Type: (Personalized) Project Report — Length: 4000 words
Weight: 100%

Scope: All intended learning outcomes of the module.
Completion: to pass this module, the examination has to be passed with at least 45%.

3.4 Elective Area

3.4.1 Society and Business Track

3.4.1.1 Cybercriminology

<table>
<tr><td colspan="3">Module Name

Cybercriminology</td><td>Module Code

MDSSB-SOCB-01</td><td>Level (type)

Year 1 or 2 (ELECTIVE)</td><td>CP

5</td></tr>
<tr><td colspan="6">Module Components

Number | Name | Type | CP
MDSSB-SOCB-01 | Cybercriminology | Seminar | 5</td></tr>
<tr><td>Module Coordinator

Prof. Dr. Hilke Brockmann</td><td colspan="3">Program Affiliation

• MSc Data Science for Society and Business (DSSB)</td><td colspan="2">Mandatory Status

Mandatory elective for CSSE and DSSB</td></tr>
<tr><td colspan="3">Entry Requirements

Pre-requisites: ☒ None
Co-requisites: ☒ None
Knowledge, Abilities, or Skills: • Python or R</td><td>Frequency

Annually (Fall)

Duration

1 semester</td><td colspan="2">Forms of Learning and Teaching

• Seminar (35 hours)
• Teamwork and Self-study (90 hours)

Workload

125 hours</td></tr>
<tr><td colspan="6">Recommendations for Preparation

Watch the ted-talk: https://www.youtube.com/watch?v=c_2Ja-OTmGc</td></tr>
<tr><td colspan="6">Content and Educational Aims

New technologies also provide new spaces and tools for deviant behavior. Cybercriminology addresses crimes committed on or facilitated by the Internet. These encompass crimes against computers—from hacking and malware attacks to cyberwarfare, crimes against intellectual, virtual, and analog properties, crimes against persons like cyberbullying and cyberstalking, and crimes involving illicit content from hate speech, to adult and child pornography.

In this module, we will learn about these cybercriminal offenses and their prevalence, along with discussing prominent court cases. We get insights into the socio-demographic and psychological profiles of cybercrime offenders and victims. We interrogate national and international cybercrime jurisdiction, policing structures, and policing techniques. At the end of the module, students will be able to engage with cybercrime experts to design and undertake policing cybercrime studies, and draft political and technical solutions to fight cybercrimes.</td></tr>
</table>

Intended Learning Outcomes

By the end of this module, students will be able to

1. know and understand the core concepts of cybercriminology, policing structures and techniques, and national as well as international cybercrime jurisdiction
2. demonstrate the ability to critically, autonomously, and creatively identify and formulate cybercrime related problems
3. demonstrate methodological knowledge in studying and critically analyzing cybercrime research questions
4. find best solutions to secure private persons, business organizations, and entire societies from cybercrime offenses
5. demonstrate insights into the possibilities and limitations of cybercrime research and their role in the society
6. formulate policy recommendations to secure firms, organizations, and private persons from cybercrimes

Indicative Literature

Jaishankar (Ed) (2011) Cyber Criminology. Exploring Internet Crimes and Criminal Behavior. Coba Raton: Taylor & Francis.
Maimon, Louderback (2019) Cyber-Dependent Crimes: An Interdisciplinary Review. Annual Review of Criminology 2, 191-216.

Usability and Relationship to other Modules

This module can be used to identify cybercrimes and address cybersecurity problems, criminal behavior, and societal and organizational responses. It connects to core and methods modules, can be important for the discovery modules, and has a direct link to “Ethics and the Information Revolution” and “IT Law.”

Examination Type: Module Examination

Assessment Type: Term Paper — Length: 3000 – 4000 words
Weight: 100%

Scope: All intended learning outcomes of the module.
Completion: to pass this module, the examination has to be passed with at least 45%.

3.4.1.2 Introduction to Computational Social Science

<table>
<tr><td colspan="2">Module Name

Introduction to Computational Social Science</td><td>Module Code

MDSSB-SOCB-02</td><td>Level (type)

Year 1
(ELECTIVE)</td><td>CP

5</td></tr>
<tr><td colspan="5">Module Components

Number | Name | Type | CP
MDSSB-SOCB-02 | Introduction to Computational Social Science | Seminar | 5</td></tr>
<tr><td>Module Coordinator

Prof. Dr. Jan Lorenz</td><td colspan="2">Program Affiliation

• MSc Data Science for Society and Business (DSSB)</td><td colspan="2">Mandatory Status

Mandatory elective for DSSB</td></tr>
<tr><td colspan="2">Entry Requirements

Pre-requisites

☒ None

Co-requisites

☒ None

Knowledge, Abilities, or Skills

☒ None</td><td>Frequency

Annually
(Spring)

Duration

1 Semester</td><td colspan="2">Forms of Learning and Teaching

• Seminar (35 hours)
• Teamwork and Self-study (90 hours)

Workload

125 hours</td></tr>
<tr><td colspan="5">Recommendations for Preparation

Install the latest version of NetLogo on your computer (https://ccl.northwestern.edu/netlogo/) and work through tutorials #1, #2, and #3.</td></tr>
<tr><td colspan="5">Content and Educational Aims

Computational social science (CSS) emphasizes the computational aspects of social sciences. While all sciences have a theoretical and an empirical component that are connected in explanatory models, CSS adds theoretical simulation techniques and empirical data processing to the analytical repertoire.

This module focuses on the theoretical simulation and the modeling of social processes and social networks to understand the emergence of social phenomena, social complexity, and cultural evolution in empirical data. Many phenomena in societies are not a simple aggregation of single properties. Instead, local interactions may trigger system dynamics, leading, to, for example, financial booms and crashes, social protests, racial and ideological segregation, or polarized opinions. Agent-based modeling (ABM) is a tool to study social processes. ABM combines elements of game theory, complex systems, emergence, computational sociology, multi-agent systems, and evolutionary programming. Social networks measure the connectivity of social agents and play a key role in the development and outcomes of social processes. In recent years, the study of networks has grown significantly because of the recent availability of social media data and other digital sources such as computer networks, semantic networks like Wikipedia, citation networks, genealogies, and other digital traces left by humans in the Internet.

Students will learn how to undertake CSS studies using ABM in the NetLogo software based on research questions and inspired or validated by digital data.</td></tr>
</table>

Intended Learning Outcomes

By the end of this module, students will be able to

1. understand and systematically explore existing agent-based models of social processes.
2. explain dynamic mechanisms and how they work similarly in different models. This includes an understanding of the concepts of static, dynamic, and stochastic equilibria and the concepts of stability and attractiveness.
3. conceptualize and analyze social phenomena as social networks. This includes explaining whether a network is a way to represent the outcome of a social process, or the input on which social processes operate, or an integral part of the dynamics itself.
4. understand and empirically validate models of network generation and their relation to certain network properties, for example, fat-tailed degree distributions or the small-world property.
5. program and own modeling idea in NetLogo.
6. describe and document agent-based models.

Indicative Literature

Payne et al. (2019). Social Simulation for a Digital Society. Applications and Innovations in Computational Social Science. Cham: Springer Nature.

Contractor (2020) How Can Computational Social Science Motivate the Development of Theories, Data, and Methods to Advance Our Understanding of Communication and Organizational Dynamics? In The Oxford Handbook of Networked Communication ed. By Foucault Welles & Gonzales-Bailon. Oxford: OUP.

Usability and Relationship to other Modules

Insights into CSS can be used in the “Digital Public Spheres” and “Data Science Lab” modules, and for the “Capstone Project” in the discovery tier of the program.

Examination Type: Module Examination

Assessment Type: Term Paper (Computer Model, Documentation, and Analysis) Length: 3000 words
Weight: 100%

Scope: All intended learning outcomes of the module.
Completion: to pass this module, the examination has to be passed with at least 45%.

3.4.1.3 Smart Cities and Transportation Concepts

<table>
<tr><td colspan="3">Module Name
Smart Cities and Transportation Concepts</td><td>Module Code
MSCM-CO-08</td><td>Level (type)
Year 2 (CORE)</td><td>CP
5</td></tr>
<tr><td colspan="6">Module Components

Number | Name | Type | CP
MSCM-CO-08 | Smart Cities and Transportation Concepts | Lecture | 5</td></tr>
<tr><td>Module Coordinator

Prof. Dr.-Ing. Hendro Wicaksono</td><td colspan="3">Program Affiliation

• MSc Supply Chain Management (SCM)</td><td colspan="2">Mandatory Status

Mandatory elective for DSSB and SCM</td></tr>
<tr><td colspan="3">Entry Requirements

Pre-requisites | Co-requisites | Knowledge, Abilities, or Skills
• MDE-CO-01 Big Data Challenge | ☒ None | ☒ None</td><td>Frequency

Annually (Fall)

Duration

1 semester</td><td colspan="2">Forms of Learning and Teaching

• Lecture and feedback sessions (35 hours)
• Group Work (45 hours)
• Private Study (45 hours)

Workload

125 hours</td></tr>
<tr><td colspan="6">Recommendations for Preparation

McClellan,S; Jimenez, J.A.; Koutitas, G.: Smart Cities Applications, Technologies, Standards, and Driving Factors, Springer, 2018.</td></tr>
<tr><td colspan="6">Content and Educational Aims

In recent years, cities around the world have been initiating and developing ideas and projects that use the word “smart.” These projects and ideas are characterized by technologies, such as green energy, artificial intelligence, internet-of-things, and self-driving vehicles, that require large amounts of data. This module focuses on the main considerations of smart-city projects, including intelligent transportation (public transportation, urban logistics, smart vehicle) and environmental infrastructure (energy, water, and waste), and the technological backbone, such as the internet-of-things, cloud computing, and data analytics.</td></tr>
<tr><td colspan="6">Intended Learning Outcomes

By the end of this module, students will be able to

1. identify typical scenarios of smart-city projects and evaluate the opportunities and challenges involved;
2. discover the backbone technologies required for intelligent transportation and environmental infrastructure and analyze the economics, ecological, and social impacts;
3. develop technological architecture concepts for typical smart-city scenarios;
4. work with smart-city datasets and analyze the data needed to improve decision-making in smart-city contexts.</td></tr>
<tr><td colspan="6">Indicative Literature

N.A.</td></tr>
</table>

Usability and Relationship to other Modules

- Concepts in MDE-CO-01 Big Data Challenge and project management concepts in MSCM-CO-01 will be applied. Academic writing skills in MSCM-CAR-01 facilitate the completion of tasks in this module.
- It serves as a mandatory elective module in the Society and Business Track for DSSB.

Examination Type: Module Examination

Assessment Type: Project Report — Length: 2.500 words, Weight: 100%

Scope: All intended learning outcomes of the module.
Completion: to pass this module, the examination has to be passed with at least 45%.

3.4.1.4 Sustainability Economics

<table>
<tr><td colspan="2">Module Name

Sustainability Economics</td><td>Module Code

MDSSB-ECON-01</td><td>Level (type)

Year 1 or 2 (ELECTIVE)</td><td>CP

5</td></tr>
<tr><td colspan="5">Module Components

Number | Name | Type | CP
MDSSB-ECON-01 | Sustainability Economics | Seminar | 5</td></tr>
<tr><td>Module Coordinator

N.N.</td><td colspan="2">Program Affiliation

• Master Data Science for Society and Business (DSSB)</td><td colspan="2">Mandatory Status

Mandatory elective for DSSB</td></tr>
<tr><td colspan="2">Entry Requirements

Pre-requisites

☒ none

Co-requisites

☒ None

Knowledge, Abilities, or Skills
• Logical and causality-based reasoning
• Researching information, assessing sources</td><td>Frequency

Annually (Fall)

Duration

1 semester</td><td colspan="2">Forms of Learning and Teaching

• Seminar (35 hours)
• Teamwork and self-study (90 hours)

Workload

125 hours</td></tr>
<tr><td colspan="5">Recommendations for Preparation

Reading the syllabus is recommended</td></tr>
<tr><td colspan="5">Content and Educational Aims

Technological changes and digitalization have made a profound impact on how businesses operate and economies develop. Digitalization will also have a substantial impact on the social, economic, and political development of countries and regions in the future. At the same time, challenges such as aging populations, financial crises, global warming, loss of biodiversity, inequality, poverty, or epidemics have become ever more pressing. To understand the opportunities that digitalization offers and at the same time to deal with these challenges, leaders with solid economic knowledge and a sense of financial, social, and ecological responsibility are needed. The Sustainability Economics module aims to create leaders and citizens who can seize the opportunities in digital transformations while being aware of the constraints posed by demographic changes, rising income inequality, resource-depletion, environmental degradation, and the unleashing of financial systems and innovations.</td></tr>
<tr><td colspan="5">Intended Learning Outcomes

By the end of this module, students will be able to
1. understand the link between digitalization and sustainable development
2. analyze economic and social inclusion
3. analyze and evaluate the functioning of the labor market 4.0
4. apply the theoretical concepts learned in class to assess the functioning and regulation of the financial systems 4.0
5. gather statistical data and use prominent news sources for in-class discussions
6. critically and independently identify the key arguments in debates
7. put the knowledge on economic policies and instruments into practice</td></tr>
</table>

Indicative Literature

Daly (1996) Beyond Growth: The Economics of Sustainable Development. Boston, MA: Beacon Press.

Usability and Relationship to other Modules

This module complements “Digital Societies and Future Economies,” “Digital Transformation and Innovation,” and “Artificial Intelligence in Business and Society” modules. It further connects to ethical questions raised in “Ethics and the Information Revolution” module.

It serves as a mandatory elective module in the Society and Business Track for DSSB.

Examination Type: Module Examination

Assessment Component 1: Presentation	Duration: 15-20 minutes Weight: 40%
Scope: Respective intended learning outcomes of the module.	
Assessment Component 2: Term paper	
Scope: Respective intended learning outcomes of the module.	Length: 1500 words Weight: 60%

Completion: This module can be passed with an assessment-component weighted average grade of 45% or higher.

3.4.1.5 Principles of Consulting

<table>
<tr><td colspan="3">Module Name
Principles of Consulting</td><td>Module Code
MSCM-CO-09</td><td>Level (type)
Year 2 (CORE)</td><td>CP
5</td></tr>
<tr><td colspan="6">Module Components

Number | Name | Type | CP
MSCM-CO-09 | Principles of Consulting | Lecture and Seminar | 5</td></tr>
<tr><td colspan="2">Module Coordinator

Prof. Dr. Yilmaz Uygun</td><td colspan="2">Program Affiliation

• MSc Supply Chain Management (SCM)</td><td colspan="2">Mandatory Status

Mandatory elective for DSSB and SCM</td></tr>
<tr><td colspan="3">Entry Requirements

Pre-requisites | Co-requisites | Knowledge, Abilities, or Skills
• MSCM-CAR-01 Communicating & Presenting | ☒ None | ☒ None

Or
• Communication & Presentation Skills for Executives (DSSB)</td><td>Frequency

Annually (Fall)

Duration

1 semester</td><td colspan="2">Forms of Learning and Teaching

• Lectures (17.5 hours)
• Seminars (17.5 hours)
• Group Work (45 hours)
• Private Study (45 hours)

Workload

125 hours</td></tr>
<tr><td colspan="6">Recommendations for Preparation

Newton, R. (2012): The Management Consultant: Mastering the Art of Consultancy. 1st edition. FT / Prentice Hall Publishing.</td></tr>
<tr><td colspan="6">Content and Educational Aims

Managing supply chains involves many activities and projects that require expert skills, which may not be available in the company. Thus, support from experienced consultants outside the company is crucial. Graduates of SCM may not end up in supply chain-related departments in companies but may also work with consultancies focusing on supply chain issues. This module gives a deep understanding of how consulting companies are run and what cross-cutting skills of consultants look like. Here, consulting processes are analyzed in detail. Additionally, the complex and intertwined roles and responsibilities of consultants and their interactions with clients are addressed. Furthermore, the different goals of internal and external consultancies are covered. Students are introduced to typical approaches and analytical tools for consultants. Case studies help students understand the phases of consultancy projects, organizational setups, and client interfaces, as well as assessments of project results.</td></tr>
<tr><td colspan="6">Intended Learning Outcomes

After successful completion of this module, students will be able to
1. apply the interdisciplinary concepts and methods of supply chain consulting;
2. independently investigate complex problems and develop creative solutions;
3. use advanced analytical tools and decide which tools and methods are optimal for each situation;
4. communicate professionally with firm experts and use their feedback to improve solutions;
5. detect potential conflicts in consultancy projects;</td></tr>
</table>

6. gain a deep understanding of supply chain processes and apply quantitative decision-making tools to improve them;
7. make systematic and data-driven decisions regarding the issues at hand and assess their impact on business processes;
8. develop a professional self-perception as consultants based on consultancy standards.

Indicative Literature

N.A.

Usability and Relationship to other Modules

Concepts of MDE-CO-01 Big Data Challenge as well as project management concepts taught in MSCM-CO-01 will be applied. Academic writing skills taught in MSCM-CAR-01 facilitate the completion of the tasks in this module.

Examination Type: Module Examination

Assessment Type: Project Report — Length: 2.500 words
Weight: 100%

Scope: All intended learning outcomes of the module.
Completion: to pass this module, the examination has to be passed with at least 45%.

3.4.2 Advanced Data Science Track

3.4.2.1 Data Analytics

<table>
<tr><td colspan="3">Module Name
Data Analytics</td><td>Module Code
MDE-CO-02</td><td>Level (type)
Year 1 or 2 (ELECTIVE)</td><td>CP
5</td></tr>
<tr><td colspan="6">Module Components

Number | Name | Type | CP
MDE-CO-02 | Data Analytics | Lecture/tutorials | 5</td></tr>
<tr><td>Module Coordinator

Prof. Dr. Adalbert F.X. Wilhelm</td><td colspan="3">Program Affiliation

• MSc Data Engineering (DE)</td><td colspan="2">Mandatory Status

Mandatory for DE and AST
Mandatory elective for DSSB and CSSE</td></tr>
<tr><td colspan="3">Entry Requirements

Pre-requisites: ☒ None
Co-requisites: ☒ None
Knowledge, Abilities, or Skills: ☒ None</td><td>Frequency

Annually (Fall)

Duration

1 semester</td><td colspan="2">Forms of Learning and Teaching

• Lecture (17.5 hours)
• Tutorials (17.5 hours)
• Private study (90 hours)

Workload

125 hours</td></tr>
<tr><td colspan="6">Recommendations for Preparation
Read the Syllabus.
Take the free online module “Introduction to Data Science” at https://cognitiveclass.ai/courses/data-science-101/</td></tr>
<tr><td colspan="6">Content and Educational Aims

This module introduces the concepts and methods of data analytics. The objective of the module is to present methods for gaining insights from data and drawing conclusions for analytical reasoning and decision making. The module comprises a broad spectrum of methods for modeling and understanding complex datasets. Comprising both descriptive and predictive analytics, the standard portfolio of supervised and unsupervised learning techniques is introduced. Automatic analysis components, such as data transformation, aggregation, classification, clustering, and outlier detection, will be treated as an integral part of the analytics process.
As a central part of this module, students are introduced to the major concepts of statistical learning, such as cross-validation, feature selection, and model evaluation. The module combines and applies the theoretical foundation of data analytics with a practical exposure to the data analysis process.</td></tr>
<tr><td colspan="6">Intended Learning Outcomes

By the end of this module, students will be able to

1. explain advanced data analytics techniques in theory and application
2. apply data analytics methods to real-life problems using appropriate tools
3. evaluate and compare different data analytics algorithms and approaches
4. apply statistical concepts to evaluate data analytics results</td></tr>
<tr><td colspan="6">Indicative Literature

G. James, D. Witten, T. Hastie, Rob Tibshirani: Introduction to Statistical Learning with R by Springer, 2013. (ISLR)
A. Telea, Data Visualization: Principles and Practice, Wellesley, Mass.: AK Peters, 1st edition, 2008. (DV)
M. Ward, G. Grinstein, D. Keim, Interactive Data Visualization: Foundations, Techniques, and Applications. AK Peters, 1st edition, 2010. (IDV)</td></tr>
<tr><td colspan="6">Usability and Relationship to other Modules</td></tr>
</table>

- In this module, students will learn the concepts and various techniques of data analysis. They will be rigorously applied in MESC001 as well as in the applied projects MRD005 and MRD006, and typically also in the master thesis.
- It serves as a mandatory elective module in the Advanced Data Science Track for DSSB.

Examination Type: Module Examination

Assessment Type: Project Report Length: 20 pages
Weight: 100%

Scope: All intended learning outcomes of the module.
Completion: to pass this module, the examination has to be passed with at least 45%.

3.4.2.2 Data Mining

Module Name	**Module Code**	**Level (type)**	**CP**
Data Mining	MDE-BSC-01	Year 1 or 2 (ELECTIVE)	5

Module Components

Number	Name	Type	CP
MDE-BSC-01	Data Mining	Lecture	5

Module Coordinator	**Program Affiliation**	**Mandatory Status**
Prof. Dr. Adalbert F.X. Wilhelm	• MSc Data Engineering (DE)	Mandatory elective for DE and DSSB

Entry Requirements			**Frequency**	**Forms of Learning and Teaching**
Pre-requisites	Co-requisites	Knowledge, Abilities, or Skills	Annually (Spring)	• Lecture (17.5 hours) • Project work (90 hours) • Private study (17.5 hours)
• Data Analytics	• Machine Learning	• Knowledge of Data Analytics software/ programming languages such as R or Python	**Duration** 1 semester	**Workload** 125 hours

Recommendations for Preparation

- Practice data analysis tasks.
- Read the Syllabus.

Content and Educational Aims

The focus of this module is on the practical applications of algorithms and computational paradigms that allow computer-based search and detection of data patterns and regularities. Students learn to use such tools to make predictions and forecasts. Students will study data mining as the core component of knowledge discovery process in databases, which deals with extracting useful information from raw data. This knowledge discovery process includes data selection, cleaning, coding, using different statistical and machine learning techniques, and the visualization of data along with generated patterns and structures. The module aims to provide an overview of all these issues and illustrates the entire process using examples.
A major component of the module is group-based participation in a data analysis competition. This competition allows students to apply the learned concepts and develop computational skills to collaboratively analyze data.

Intended Learning Outcomes

By the end of this module, students will be able to

1. implement and apply advanced data mining methods with appropriate tools
2. evaluate and compare the suitability, scalability, and efficiency of different methods in practical scenarios
3. gain experience in performing a full cycle of data mining and data analysis
4. acquire practical skills to tackle data mining problems

Indicative Literature

G. James, D. Witten, T. Hastie, R. Tibshiran, Introduction to Statistical Learning with R by Springer, 2013 (ISLR).
J. VanderPlas, Python Data Science Handbook, 2016 - https://jakevdp.github.io/PythonDataScienceHandbook/.

Usability and Relationship to other Modules

- This module builds on the core data analytics MC0011 module and prepares students for applied projects in data analysis as well as a master thesis in this field.
- It serves as a mandatory elective module in the Advanced Data Science Track for DSSB.

Examination Type: Module Examination

Assessment Type: Project Report — Length: 20 pages
Weight: 100%

Scope: All intended learning outcomes of the module.

Completion: To pass this module, the examination has to be passed with at least 45%.

3.4.2.3 Introduction to Data Management with Python

<table>
<tr><td colspan="3">Module Name
Introduction to Data Management with Python</td><td>Module Code
MDE-MET-03</td><td>Level (type)
Year 1 or 2 (ELECTIVE)</td><td>CP
5</td></tr>
<tr><td colspan="6">Module Components

Number | Name | Type | CP
MDE-MET-03-A | Introduction to Data Management with Python - Lecture | Lecture | 2.5
MDE-MET-03-B | Introduction to Data Management with Python - Tutorial | Tutorial | 2.5</td></tr>
<tr><td colspan="2">Module Coordinator

Dr. Carlos Brandt</td><td colspan="2">Program Affiliation

• MSc Data Engineering (DE)</td><td colspan="2">Mandatory Status

Mandatory for DE, mandatory elective for DSSB</td></tr>
<tr><td colspan="3">Entry Requirements

Pre-requisites | Co-requisites | Knowledge, Abilities, or Skills
☒ None | ☒ None | ☒ None</td><td>Frequency

Annually (Fall)</td><td colspan="2">Forms of Learning and Teaching

• Lecture attendance (17.5 hours)
• Tutorial attendance (17.5 hours)
• Private Study (90 hours)</td></tr>
<tr><td colspan="3"></td><td>Duration

1 semester</td><td colspan="2">Workload

125 hours</td></tr>
<tr><td colspan="6">Recommendations for Preparation

None.</td></tr>
<tr><td colspan="6">Content and Educational Aims

This module introduces Python to the field of data management. Data management includes a number of methodologies to collect, store, process, and provision data. The aim of this module is to focus on an applied view of these tasks. Since Python has become the de-facto standard in the field, the module is initially concerned with a basic introduction on the core concepts of imperative programming in Python. Data structures and fundamental algorithms are discovered in a hands-on manner. These will also include basic numerical and data analysis tasks based on NumPy/SciPy. Relational databases are a source from which we can collect and in which we can store data. The module introduces the structured query language (SQL) to access this data source. More recently, data is frequently stored in Data Frames, a data structure provided by Pandas, a Python library. Pandas also provides the functionality to carry out data analysis tasks. Provisioning of data analysis outputs will be done using basic 2D visualization techniques.</td></tr>
<tr><td colspan="6">Intended Learning Outcomes

1. By the end of this module, students will be able to
2. explain and apply fundamental concepts of imperative programming using Python
3. understand and use basic data structures
4. summarize and apply fundamental algorithms (e.g. sorting)
5. execute basic data analysis tasks (average, min, max, ...)
6. Understand and implement linear algebra operations using NumPy/SciPy
7. explain fundamentals of relational databases
describe and use SQL to create, modify and query data from relational databases</td></tr>
</table>

8. understand and apply DataFrames and data analysis using Pandas
9. visualize simple data by different types of 2D plots using Matplotlib

Indicative Literature

Jake VanderPlas, Python Data Science Handbook, O'Reilly.
Cay S. Horstmann, Rance D. Necaise, Python for Everyone, 3rd Edition, Wiley.

Usability and Relationship to other Modules

- The module provides the necessary background knowledge for modules such as “Advanced Databases” or “Machine Learning.”
- It serves as a mandatory elective module in the Advanced Data Science Track for DSSB.

Examination Type: Module Component Examinations

Module Component 1: Lecture

Assessment Type: Written Examination — Duration: 120 min, Weight: 50%

Scope: All intended learning outcomes of the module, excluding practical aspects.

Module Component 2: Tutorial

Assessment Type: Programming Assignments — Weight: 50%

Scope: All practical aspects of the intended learning outcomes.

Completion: to pass this module, the examination of each module component has to be passed with at least 45%

3.4.2.4 Machine Learning

<table>
<tr><td colspan="3">Module Name
Machine Learning</td><td>Module Code
MDE-CO-04</td><td>Level (type)
Year 1 (CORE)</td><td>CP
5</td></tr>
<tr><td colspan="6">Module Components

Number | Name | Type | CP
MDE-CO-04 | Machine Learning | Lecture | 5</td></tr>
<tr><td>Module Coordinator

Prof. Dr. Stefan Kettemann</td><td colspan="3">Program Affiliation

• MSc Data Engineering (DE)</td><td colspan="2">Mandatory Status

Mandatory for DE

Mandatory elective for CSSE and DSSB</td></tr>
<tr><td colspan="3">Entry Requirements

Pre-requisites: ☒ None
Co-requisites: ☒ None
Knowledge, Abilities, or Skills:
• Basic linear algebra, calculus and probability theory, as typically acquired in entry modules in BSc studies</td><td>Frequency

Annually (Spring)

Duration

1 semester</td><td colspan="2">Forms of Learning and Teaching

• Lectures (35 hours)
• Private Study, incl. exercises and Examination preparation (90 hours)

Workload

125 hours</td></tr>
<tr><td colspan="6">Recommendations for Preparation

Read the syllabus.
Highly recommended: Mitchell, Tom M.: Machine Learning (McGraw-Hill, 1997) IRC: Q325.5.M58 1997. This standard, classical textbook gives a very accessible overview of ML.</td></tr>
<tr><td colspan="6">Content and Educational Aims

Machine learning (ML) is a module that concerns algorithms that are fed with (large quantities of) real-world data, and which return a compressed "model" of the data. An example is the "world model" of a robot: the input data are sensor data streams, from which the robot learns a model of its environment. Another example is a spoken language model: the input data are speech recordings, from which ML methods build a model of spoken English -- useful, for instance, in automated speech recognition systems. There are many formalisms in which such models can be cast, and an equally large diversity of learning algorithms. At the same time, there is a relatively small number of fundamental challenges that are common to all of these formalisms and algorithms.

The module introduces such fundamental concepts and illustrates them with a choice of elementary model formalisms (linear classifiers and regressors, radial basis function networks, clustering, neural networks). Furthermore, the module also (re)introduces required mathematical material from probability theory and linear algebra. The main educational aims are twofold: to make students fully aware of the two main hurdles for obtaining good models from data: (i) the "curse of dimensionality" and (ii) the bias-variance dilemma and to provide standard tools to cope with these difficulties, namely (i') dimension reduction by feature extraction, for example via PCA or clustering, and (ii') cross-validation and regularization.</td></tr>
<tr><td colspan="6">Intended Learning Outcomes

Upon completion of this module, students will be able to

1. design, implement and exploit elementary supervised ML methods for classification and regression with expert care given to dimension reduction preprocessing and regularization;
2. understand and practically use PCA and linear regression;</td></tr>
</table>

3. understand the core ideas behind feedforward neural networks and the backpropagation algorithm, as the basis for accessing "deep learning" methods.

Indicative Literature

T. M. Mitchel, Machine Learning, McGraw-Hill, 1997, IRC: Q325.5.M58.

Usability and Relationship to other Modules

This module is a natural companion to the "Principles of Statistical Modeling" (PSM) module MDE-CS-03.
The ML module focuses on practical ML skills, whereas PSM module on rigorous mathematical formalism and analysis.
For students not familiar with graph theory, it is recommended to take the first semester module MDE-CS-01 Network Theory, which introduces concepts used in this Machine Learning module.

Examination Type: Module Examination

Assessment Type: Written Examination

Duration: 120 minutes
Weight: 100%

Scope: All intended learning outcomes of this module.
Completion: to pass this module, the examination has to be passed with at least 45%.

3.4.3 Environment and Health Track

3.4.3.1 Geoinformatics

<table>
<tr><td colspan="3">Module Name
Geoinformatics</td><td>Module Code
MDE-GEO-01</td><td>Level (type)
Year 1 or 2 (ELECTIVE)</td><td>CP
5</td></tr>
<tr><td colspan="6">Module Components</td></tr>
<tr><td>Number</td><td colspan="3">Name</td><td>Type</td><td>CP</td></tr>
<tr><td>MDE-GEO-01-A</td><td colspan="3">Geo-Information Systems</td><td>Lecture</td><td>2.5</td></tr>
<tr><td>MDE-GEO-01-B</td><td colspan="3">Introduction to Earth System Data</td><td>Lecture</td><td>2.5</td></tr>
<tr><td>Module Coordinator
Prof. Dr. Vikram Unnithan</td><td colspan="3">Program Affiliation
• MSc Data Engineering (DE)</td><td colspan="2">Mandatory Status
Mandatory elective for DE and DSSB</td></tr>
<tr><td colspan="2">Entry Requirements
Pre-requisites
☒ None</td><td>Co-requisites
☒ None</td><td>Knowledge, Abilities, or Skills
• Basic computer skills, basic working knowledge of Linux OS and Python</td><td>Frequency
Annually (Fall)

Duration
1 semester</td><td colspan="2">Forms of Learning and Teaching
• Lecture attendance (40 hours)
• Practical assignments (40 hours)
• Private study (45 hours)

Workload
125 hours</td></tr>
<tr><td colspan="6">Recommendations for Preparation
• Read the Syllabus
• Geographic Information Systems and Science, 2nd Edition (2005)
• Paul A. Longley, Michael F. Goodchild, David J. Maguire, David W. Rhind. Wiley, 560 p. ISBN 0470721448
• Python Data Science Handbook, Jake VanderPlas, 2016 - https://jakevdp.github.io/PythonDataScienceHandbook/</td></tr>
<tr><td colspan="6">Content and Educational Aims
This module introduces geographic information system (GIS) techniques, principles of spatial analysis, and data mining with GIS, remote sensing, and GPS integration. It also provides an early exposure to earth science data and its handling. A wide range of datasets, collected remotely or in-situ, are introduced, and examples provided along with their relevance to earth science disciplines. This module provides the necessary skills and expertise for analyzing and modeling geospatial and/or temporal data. Emphasis is also given to the integration, analysis, management, and visualization of large volumes of spatial data from multiple sources at a variety of scales.</td></tr>
<tr><td colspan="6">Intended Learning Outcomes
Upon the completion of this module, students will be able to
1. comprehend the fundamental concepts and practices of GIS, remote sensing, earth science data, and geospatial analysis and modeling, and apply basic mapping, graphic, and data visualization concepts.
2. apply GIS analysis to address geospatial/temporal problems and/or research questions.
3. apply mathematical and modeling concepts, including statistical methods, to geospatial analysis.</td></tr>
<tr><td colspan="6">Indicative Literature
The module is based on a self-contained, detailed set of online lecture notes.
Nevertheless, the following references provide a good overview of the material covered:
P. A. Longley, M. F. Goodchild, D. J. Maguire, D. W. Rhind, Geographic Information Systems and Science, 2nd Edition, Wiley, 2005, 560 p. ISBN 0470721448.</td></tr>
</table>

Jake VanderPlas, Python Data Science Handbook, 2016, https://jakevdp.github.io/PythonDataScienceHandbook/.

Usability and Relationship to other Modules

- This module is a natural companion to the "Principles of Statistical Modeling" (PSM) module MECS001.
- The ML module focuses on practical ML skills, whereas PSM module on rigorous mathematical formalism and analysis.
- For students not familiar with graph theory, it is recommended to take the first semester module MECS002 Network Theory, which introduces concepts used in this Machine Learning module.
- It serves as a mandatory elective module in the Environment and Health Track for DSSB.

Examination Type: Module Examination

Assessment Type: Term Paper Length: 20 pages
Weight: 100%

Scope: All intended learning outcomes of the module.
Completion: to pass this module, the examination has to be passed with at least 45%.

3.4.3.2 Geoinformatics Lab

<table>
<tr><td colspan="3">Module Name
Geoinformatics Lab</td><td>Module Code
MDE-GEO-02</td><td>Level (type)
Year 1 or 2 (ELECTIVE)</td><td>CP
5</td></tr>
<tr><td colspan="6">Module Components

Number | Name | Type | CP
MDE-GEO-02 | Geoinformatics Lab | Lab | 5</td></tr>
<tr><td colspan="2">Module Coordinator

Prof. Dr. Vikram Unnithan</td><td colspan="2">Program Affiliation

• MSc Data Engineering (DE)</td><td colspan="2">Mandatory Status

Mandatory elective for DE and DSSB</td></tr>
<tr><td colspan="3">Entry Requirements

Pre-requisites: ☒ None
Co-requisites: • Geo-informatics
Knowledge, Abilities, or Skills: • Basic computer skills</td><td>Frequency

Annual (Spring)

Duration

1 semester</td><td colspan="2">Forms of Learning and Teaching

• Lecture attendance (40 hours)
• Practical assignments (40 hours)
• Private study (45 hours)

Workload

125 hours</td></tr>
<tr><td colspan="6">Recommendations for Preparation

• Read the Syllabus.
• Python Data Science Handbook, Jake VanderPlas, 2016 - https://jakevdp.github.io/PythonDataScienceHandbook/
• Geospatial Data and Analysis, Bill Day, Jon Bruner, Aurelia Moser, 2017, O'Reilly Media, Inc. ISBN: 9781491984314</td></tr>
<tr><td colspan="6">Content and Educational Aims

This lab module provides the necessary hands-on skills and expertise needed to gather, analyze, and model geospatial and/or temporal data. Integration, analysis, management, and visualization of large volumes of spatial data from multiple sources at a variety of scales form a part of the assignments and lab work. Students may also have to design, integrate, and implement a variety of sensors to gather, process, visualize, and analyze environmental, oceanographic, or other geo data. Theoretical concepts are demonstrated, and practical training is provided using state-of-the-art software and hardware. Examples of applications in various fields such as geo-and bio-sciences, data management, habitat management, risk assessment, and geo-marketing are discussed, and the role of the Internet in data mining and Web GIS is illustrated.</td></tr>
<tr><td colspan="6">Intended Learning Outcomes

By the end of this module, students will be able to

1. design, implement, and exploit elementary supervised ML methods for classification and regression with expert care given to dimension reduction preprocessing and regularization
2. understand and practically use PCA and linear regression
3. understand the core ideas behind feedforward neural networks and the backpropagation algorithm as the basis for accessing “deep learning” methods.</td></tr>
<tr><td colspan="6">Indicative Literature

J. VanderPlas, Python Data Science Handbook, 2016, https://jakevdp.github.io/PythonDataScienceHandbook/.
B. Day, J. Bruner, A. Moser, Geospatial Data and Analysis, O'Reilly Media, 2017, ISBN: 9781491984314</td></tr>
<tr><td colspan="6">Usability and Relationship to other Modules

• MEGI001 – Geoinformatics is ideally a pre-requisite but due to schedule constraints it is a co-requisite.</td></tr>
</table>

- Uses and builds on concepts from all CORE modules, in particular MCO003, MCO011, MCO014 and MCO015
- Serves as a mandatory elective module in the Environment and Health Track for DSSB.

Examination Type: Module Examination

Assessment Type: Term Paper — Length: 20 pages
Weight: 100%

Scope: All intended learning outcomes of the module.
Completion: To pass this module, the examination has to be passed with at least 45%.

3.4.3.3 Modeling and Analysis of Complex Systems

<table>
<tr><td colspan="3">Module Name
Modeling and Analysis of Complex Systems</td><td>Module Code
MEBI003-ModCompSys</td><td>Level (type)
Year 1 or 2 (ELECTIVE)</td><td>CP
5</td></tr>
<tr><td colspan="6">Module Components

Number | Name | Type | CP
MEBI003-550453 | Modeling and Analysis of Complex Systems | Lecture | 2.5</td></tr>
<tr><td>Module Coordinator

Prof. Dr. Agostino Merico</td><td colspan="3">Program Affiliation

• MSc Data Engineering</td><td colspan="2">Mandatory Status

Mandatory elective for DE and DSSB</td></tr>
<tr><td colspan="3">Entry Requirements

Pre-requisites: ☒ None
Co-requisites: ☒ None
Knowledge, Abilities, or Skills: • Analysis, Basic Calculus, and Linear Algebra</td><td>Frequency

Annually (Fall)

Duration

1 semester</td><td colspan="2">Forms of Learning and Teaching

• Lecture attendance (35 hours)
• Practical exercises, private study incl. exam preparation (90 hours)

Workload

125 hours</td></tr>
<tr><td colspan="6">Recommendations for Preparation

Read the Syllabus.</td></tr>
<tr><td colspan="6">Content and Educational Aims

This is a hands-on module on the mathematical and computational modeling of various complex systems, covering diverse fields in natural and social sciences. The module starts with an introduction to mathematical modeling. The elements of a model are presented and the steps to be followed when constructing a model are reviewed, from formulating the question, determining the basic constituents of a model, and qualitatively and quantitatively describing the relevant system, to analyzing the equations with various checks and balances. An introduction is provided on Python, the programming language constituting the main computational tool adopted in the module. To put into practice the basics of modeling and Python programming, a number of classical models in ecology are reviewed, coded, and numerically analyzed. This will build the skills for developing models that describe different complex systems and the associated processes. In particular, differential equation models are developed. They describe:

(1) the dynamics of diseases such as HIV, (2) the microbial growth in batch and chemostat cultures, (3) the dynamics of plankton ecosystems in the oceanic mixed layer, and (4) examples of life acting as a regulating force at a planetary scale. In addition, the lecturer introduces ABM techniques, with applications in cultural segregation problems and spatially explicit predator-prey interactions.</td></tr>
<tr><td colspan="6">Intended Learning Outcomes

By the end of this module, students will be able to

1. independently design and develop models (from the basic conceptual aspects to the mathematical equations and numerical codes) for tackling problems in natural and social sciences
2. undertake numerical equilibria and stability analysis to evaluate model performance and identify uncertainties in model results.</td></tr>
</table>

Indicative Literature

The module is based on a self-contained, detailed set of online lecture notes and practical exercises.

Usability and Relationship to other Modules

- It serves as a mandatory elective module in the Environment and Health Track for DSSB.

Examination Type: Module Examination

Assessment Type: Written Examination Duration: 120 min
Weight: 100%

Scope: All intended learning outcomes of the module.
Completion: to pass this module, the examination has to be passed with at least 45%.

3.4.3.4 Network Approaches in Biology and Medicine

<table>
<tr><td colspan="3">Module Name

Network Approaches in Biology and Medicine</td><td>Module Code

MMM007-NetBioMed</td><td>Level (type)

Year 1 or 2 (ELECTIVE)</td><td>CP

5</td></tr>
<tr><td colspan="6">Module Components

Number | Name | Type | CP
MMM007-550443 | Network Approaches in Biology and Medicine | Lecture | 5</td></tr>
<tr><td>Module Coordinator

Prof. Dr. Marc-Thorsten Hütt</td><td colspan="3">Program Affiliation

• MSc Data Engineering (DE)</td><td colspan="2">Mandatory Status

Mandatory elective for DE and DSSB</td></tr>
<tr><td colspan="3">Entry Requirements

Pre-requisites: ☒ None
Co-requisites: • Geoinformatics
Knowledge, Abilities, or Skills: • Analysis, Basic Calculus, and Linear Algebra</td><td>Frequency

Annually (Fall)

Duration

1 semester</td><td colspan="2">Forms of Learning and Teaching

• Lecture attendance (35 hours)
• Private study (90 hours)

Workload

125 hours</td></tr>
<tr><td colspan="6">Recommendations for Preparation

Read the Syllabus.</td></tr>
<tr><td colspan="6">Content and Educational Aims

“Network science” employs a formal view of the graph theory to understand the design principles of complex systems. Abstracting cellular processes from biology into networks can contribute to understanding how such cellular systems function. Over the last two decades, this approach has revolutionized the way we think about biological systems.

Here, the application of network analysis in biology and medicine are discussed. This module discusses standard networks in systems biology (gene-regulatory networks, metabolic networks, signaling networks, and protein-protein interaction networks), in which each link corresponds to a specific biological process. It is enhanced by a discussion on relational networks, which are capable of serving as efficient sources of data integration and interpretation: a network where a disease is linked to a gene, in which there is evidence relating the gene to the disease; and the drug-target network, where drugs and proteins are linked by drug-target associations.
In addition to standard review articles and textbooks on network science, material from recent scientific literature is incorporated in the module.</td></tr>
<tr><td colspan="6">Intended Learning Outcomes

By the end of this module, students will be able to

1. understand the basic principles of network science applications in biology and medicine
2. access and use the main bio-informatics databases to obtain biological networks
3. analyze biological networks
4. combine multiple data analysis tools for a comprehensive analysis of molecular data
5. detailly describe essential facts and theoretical concepts from recent scientific literature
6. identify open questions from the scientific literature and synthesize information from the literature into a scientific presentation.</td></tr>
</table>

Indicative Literature

A.-L. Barabási, Network science. Cambridge University Press, 2016.

Alon, U. (2007). Network motifs: theory and experimental approaches. Nature Reviews Genetics, 8(6):450–461.

A.-L. Barabási (2012), The network takeover. Nature Physics, 8(1):14–16.

A.-L. Barabási, N. Gulbahce and Loscalzo (2011). Network medicine: a network-based approach to human disease. Nature reviews. Genetics, 12(1):56.

Barabási, A.-L. and Oltvai, Z. N. (2004). Network biology: understanding the cell's functional organization. Nature reviews. Genetics, 5(2):101.

Radde, N. E. and Hütt, M.-T. (2016). The physics behind systems biology. EPJ Nonlinear Biomedical Physics, 4(1):7.

Strogatz, S. H. (2001). Exploring complex networks. Nature, 410(6825):268.

and recent scientific literature.

Usability and Relationship to other Modules

It serves as a mandatory elective module in the Environment and Health track for DSSB.

Examination Type: Module Examination

Assessment Type: Presentation

Duration: 30 min
Weight: 100%

Scope: All intended learning outcomes of the module.
Completion: to pass this module, the examination has to be passed with at least 45%.

3.5 Career Area

3.5.1 Language Skills I, II, and III

The descriptions of the language modules are provided in a separate document, the "Language Module Handbook" that can be accessed from here: https://constructor.university/student-life/language-community-center/learning-languages

Language III is one of the three career modules (IT Law, Language III, Ethics and Information Revolution) that can be replaced by the internship. Students need to replace 10 CP in order to do the internship.

3.5.2 Communication and Presentation Skills for Executives

<table>
<tr><td colspan="3">Module Name

Communication and Presentation Skills</td><td>Module Code

MCA006</td><td>Level (type)

Year 1 (CAREER)</td><td>CP

2.5</td></tr>
<tr><td colspan="6">Module Components</td></tr>
<tr><td>Number</td><td colspan="3">Name</td><td>Type</td><td>CP</td></tr>
<tr><td>MCA006-051464</td><td colspan="3">Communication and Presentation Skills for Executives</td><td>Seminar</td><td>2.5</td></tr>
<tr><td>Module Coordinator

Prof. Dr. Stefan Kettemann, Prof. Dr. Hilke Brockmann</td><td colspan="3">Program Affiliation

• MSc Data Engineering (DE)</td><td colspan="2">Mandatory Status

Mandatory for DE and DSSB</td></tr>
<tr><td colspan="3">Entry Requirements

Pre-requisites

☒ None</td><td>Frequency

Annually (Fall)</td><td colspan="2">Forms of Learning and Teaching

• Seminar (17.5 hours)
• Private study (45 hours)</td></tr>
<tr><td colspan="3">Co-requisites

☒ None</td><td>Duration

1 semester</td><td colspan="2">Workload

62.5 hours</td></tr>
<tr><td colspan="3">Knowledge, Abilities, or Skills

☒ None</td><td colspan="3"></td></tr>
<tr><td colspan="6">Recommendations for Preparation

Read the Syllabus.</td></tr>
<tr><td colspan="6">Content and Educational Aims

An executive career in an international business or international organization environment requires excellent communication and presentation skills. Managers need to communicate effectively with a large variety of target audiences, often in different languages and with different cultural backgrounds. This is true for employees and/or direct reports, business and negotiating partners, as well as customers or clients. The ability to present and communicate succinctly and confidently while being culturally aware and building rapport and trust with different audiences is crucial. In this interactive module, students are introduced to the basics of effective presentation and communication techniques. They learn how to effectively present themselves, their business project, or academic work, by tailoring both the content and their delivery style to different types of audiences.</td></tr>
<tr><td colspan="6">Intended Learning Outcomes

Upon completion of the module, students will be able to</td></tr>
</table>

1. act as effective communicators—in both group and individual situations
2. understand interpersonal communication models and group dynamics in presentations
3. enjoy the process of presentation
4. understand the importance of building rapport and trust with audiences
5. use presentation software (PowerPoint, Prezi) confidently and in a visually pleasant manner
6. learn to coherently structure presentations and develop captivating narratives
7. work with different presentation formats (Ignite, Pecha Kucha, Pitching, etc.)
8. understand and apply the basics of logical reasoning in oration (deductive/inductive)
9. develop oratory and rhetorical skills by drawing on Aristotle's teachings of logos, ethos, and pathos
10. understand and apply the basics of interpersonal communication (Johari Window, 4-Ears model, etc.)
11. give and receive constructive feedback
12. present themselves in different business situations
13. collaborate effectively in intercultural teams

Indicative Literature

This module utilizes lecture formats, case studies, and interactive presentations, discussions, role play, and peer-to-peer coaching. The module will also use Internet resources, videos, and home assignments to illustrate and practice specific communication aspects.

Usability and Relationship to other Modules

It is a pre-requisite for DSSB for Principles of Consulting.

Examination Type: Module Examination

Assessment Type: Oral Presentation — Duration: 15 min, Weight: 100%

Scope: All intended learning outcomes of the module.
Completion: to pass this module, the examination has to be passed with at least 45%.

3.5.3 IT Law

Module Name			**Module Code**	**Level (type)**	**CP**
IT Law			MDSSB-LAW	Year 1 (CAREER)	2.5
Module Components					
Number	Name			Type	CP
MDSSB-LAW-01	IT Law			Lecture	2.5
Module Coordinator	**Program Affiliation**			**Mandatory Status**	
Prof. Dr Hilke Brockmann/ Prof. Dr. Stefan Kettemann	• MSc Data Science for Society and Business (DSSB)			Mandatory for DE, mandatory elective for DSSB	
Entry Requirements			**Frequency**	**Forms of Learning and Teaching**	
Pre-requisites	Co-requisites	Knowledge, Abilities, or Skills	Annually (Spring)	• Lecture (17.5 hours) • Private study (45 hours)	
☒ None	☒ None	☒ None			
			Duration	**Workload**	
			1 Semester	62.5 hours	

Recommendations for Preparation

None.

Content and Educational Aims

Digital information, the Internet, and applications like YouTube or social networking tools like Instagram, Facebook, or Twitter have disrupted legal systems (Murray 2016). IT law is not limited to one legal area but encompasses civil, public, and criminal laws. It spans from human rights law to intellectual property law, contract and consumer protection law, privacy law, data protection law, and other legal domains. Moreover, the global exchange of data is in conflict with the territorial principle of jurisdiction. In addition, IT regulations are in a constant flux to keep up with the accelerated pace of technological progress. This module looks into the most important areas of IT law. It provides the participants with a sound understanding of legal principles and regulations, and sheds light on international as well as European ICT policies and governance. A special focus will be given to the European General Data Protection Regulation (GDPR).

Intended Learning Outcomes

By the end of this module, students will be able to

1. identify legal questions and implications in relation to digital transformation technologies/IT law/ AI and algorithms
2. understand fundamental national and international legal frameworks related to the use of data
3. know the relevant IP rights regarding data and algorithms
4. understand and critically assess legal regulations about data privacy and data protection
5. recognize and explain the types of bias inherent in data processing
6. explain the legal concerns related to data-based automatic decision making
7. understand how to comply to the GDPR and assess its impact on individuals, firms, and organizations

8. understand and critically evaluate the liabilities and available remedies with regard to data
9. explain and develop potential future IT regulation mechanisms

Indicative literature

Lloyd (2020). Information Technology Law. Oxford: Oxford University Press (9th ed).

Usability and Relationship to other Modules

For DSSB students: It is one of the three Career modules (IT Law, Language III, and Ethics and the Information Revolution) that can be chosen for replacement by the internship. Students need to replace 10 CP for the internship.

Examination Type: Module Examination

Assessment Type: Term Paper Length: 3500 words
Weight: 100%

Scope: All intended learning outcomes of the module.
Completion: to pass this module, the examination has to be passed with at least 45%.

3.5.4 Ethics and the Information Revolution

<table>
<tr><td colspan="3">Module Name

Ethics and the Information Revolution</td><td>Module Code

MDSSB-EIR-01</td><td>Level (type)

Year 2
(Career)</td><td>CP

2.5</td></tr>
<tr><td colspan="6">Module Components

Number | Name | Type | CP
MDSSB-EIR-01 | Ethics and the Information Revolution | Seminar | 2.5</td></tr>
<tr><td>Module Coordinator

Prof. Dr. Hilke Brockmann</td><td colspan="3">Program Affiliation

• MSc Data Science for Society & Business (DSSB)</td><td colspan="2">Mandatory Status

Mandatory for DE, mandatory elective for DSSB</td></tr>
<tr><td colspan="3" rowspan="2">Entry Requirements

Pre-requisites | Co-requisites | Knowledge, Abilities, or Skills
☒ None | ☒ None | ☒ None</td><td>Frequency

Annual (Fall)</td><td colspan="2">Forms of Learning and Teaching

• Seminar (17.5 hours)
• Private study (45 hours)</td></tr>
<tr><td>Duration

1 semester</td><td colspan="2">Workload

62.5 hours</td></tr>
<tr><td colspan="6">Recommendations for Preparation

Read the Syllabus.
Binns (2018) Fairness in Machine Learning: Lessons from Political Philosophy. Proceedings of Machine Learning Research 81:1-11.</td></tr>
<tr><td colspan="6">Content and Educational Aims

Many data specialists claim that we are at the cusp of an information revolution. Based on inventions dating back to WWII, IT innovations have re-organized our society around one “big metadata computer” that is permanently computing data and associating metadata about everything we do. Digital technologies also have the potential to disrupt the ethical standards and rules of our society. In this module, we discuss whether we have to forfeit privacy in times of big data, if machines compromise our identity, and if shared data enables institutions to abuse their power and undermine the civil society?

The module pursues three goals. 1. Participants will immerse themselves and learn about core ethical theories. 2. They will integrate this theoretical knowledge and develop a “Big Data Ethics,” which they 3. will put into practice. For the second and third purposes, in-classroom discussions and interactions are indispensable for identifying possible dilemmas and conflict of interests and for balancing contradictions to derive practical solutions and policy advice.</td></tr>
<tr><td colspan="6">Intended Learning Outcomes

By the end of the module, students will be able to

1. report on major ethical theories relevant to digital technologies
2. integrate different ethical standpoints and arguments to address concrete societal problems
3. assess the societal and ethical implications of digitization
4. deal with legal aspects of ethics by applying means to prevent and deal with violations of privacy and transparency
5. apply actions to contribute to the transition to a more just and trustworthy digital transformation as a part of one’s job
6. implement justice and social equality as dimensions of ethics and sustainability</td></tr>
<tr><td colspan="6">Indicative Literature

Binns (2018) Fairness in Machine Learning: Lessons from Political Philosophy. Proceedings of Machine Learning Research 81:1-11.</td></tr>
</table>

Usability and Relationship to other Modules

It is one of the three Career modules (IT Law, Language III, and Ethics and the Information Revolution) that can be chosen for replacement by the internship. Students need to replace 10 CP for the internship.

Examination Type: Module Examination

Assessment Type: Term Paper (report) Length: 20 pages
Weight: 100%

Scope: All intended learning outcomes of the module.
Completion: to pass this module, the examination has to be passed with at least 45%.

3.5.5 Internship

<table>
<tr><td colspan="3">Module Name

Internship</td><td>Module Code

MDSSB-INT-01</td><td>Level (type)

Year 2
(CAREER)</td><td>CP

10</td></tr>
<tr><td colspan="6">Module Components

Number | Name | Type | CP
MDSSB-INT-01 | Internship | Project/Internship | 10</td></tr>
<tr><td>Module Coordinator

H. Brockmann/
A. Wilhelm</td><td colspan="3">Program Affiliation

• MSc Data Science for Society and Business (DSSB)</td><td colspan="2">Mandatory Status

Mandatory elective for DSSB</td></tr>
<tr><td colspan="3">Entry Requirements

Pre-requisites: • all mandatory core and methods modules of year 1
Co-requisites: ☒ None
Knowledge, Abilities, or Skills: ☒ None</td><td>Frequency

Annual (Summer Break/Fall)

Duration

6 weeks</td><td colspan="2">Forms of Learning and Teaching

• Internship (231 hours)
• Project work and report (19 hours)

Workload

250 hours</td></tr>
<tr><td colspan="6">Recommendations for Preparation

• Active preparation and training for working in a professional environment by training in German language and business etiquettes</td></tr>
<tr><td colspan="6">Content and Educational Aims

Students can undertake an internship in a company, government institution, or non-governmental organization to gain practical work experience and to start applying their knowledge into practice. A minimum of 231 working hours (i.e., 6 weeks of full-time occupation) is required for the successful completion of this module. To be professionally eligible, the content of the internship must be relevant to data science. The tasks to be executed during the internship should be appropriate for a master's level student. The module coordinator and Career Service Center support students in finding suitable positions. The module coordinator also decides on the professional eligibility of the internship. It is recommended to submit an internship work program prior to starting the internship.

The internship provides training and experiential learning opportunities for data handling, data analytics, and data interpretation in a professional setting. It assists the students' development of employer-valued skills, such as teamwork, communication, steadiness, and attention to detail. It exposes the students to the environment and performance expectations in the corporate world, may help prepare an application-oriented master thesis, and may make the entry into the professional job market easier.</td></tr>
</table>

Intended Learning Outcomes

By the end of this module, students will be able to

1. apply data science concepts and tools to real-world decision making
2. demonstrate professional work attitude and business etiquettes
3. collaborate effectively in a professional environment
4. demonstrate a solid work ethic and professional demeanor
5. demonstrate commitment to ethical conduct and legal regulations
6. improve reporting skills
7. communicate results to a non-expert audience

Usability and Relationship to other Modules

- The internship replaces the Capstone project and two of the following Career modules (IT Law, Language III, Ethics and the Information Revolution)

Examination Type: Module Examination

Assessment Type: Internship Report Length: 2000 words
Weight: 100%

Scope: All intended learning outcomes of the module.
Completion: to pass this module, the examination has to be passed with at least 45%.

3.6 Master Thesis

<table>
<tr><td colspan="3">Module Name
Master Thesis DSSB</td><td>Module Code
MDSSB-THE-01</td><td>Level (type)
Year 2 (Thesis)</td><td>CP
30</td></tr>
<tr><td colspan="6">Module Components
Number | Name | Type | CP
MDSSB-THE-01 | Master Thesis DSSB | Thesis | 30</td></tr>
<tr><td>Module Coordinator
Study Program Chair</td><td colspan="3">Program Affiliation
• MSc Data Science for Society & Business (DSSB)</td><td colspan="2">Mandatory Status
Mandatory for DSSB</td></tr>
<tr><td colspan="3">Entry Requirements
Pre-requisites: • all CORE modules completed
Co-requisites: ☒ None
Knowledge, Abilities, or Skills: • comprehensive knowledge of the subject area and deeper insight into a respective topic • skills to identify relevant research and critically review respective literature • ability to design and undertake demanding scientific research independently</td><td>Frequency
Annual (Spring)

Duration
1 semester</td><td colspan="2">Forms of Learning and Teaching
• Self-study/lab work (725 hours)
• Seminars (25 hours)

Workload
750 hours</td></tr>
<tr><td colspan="6">Recommendations for Preparation
• Identify a topic of interest and discuss this with your prospective supervisor at an appropriate time.
• Draft a research proposal, including a research plan, to ensure timely submission.
• Be equipped with all necessary technical research skills.
• Review the University’s Code of Academic Integrity and Guidelines to Ensure Good Academic Practice.</td></tr>
</table>

Content and Educational Aims

The master thesis demonstrates the student's ability to independently solve data science problems with a scientific approach and scientific methods within a set period of time. This module is a mandatory graduation requirement for all graduate students. Although supervised, the module requires students to work on their problem continuously, self-determined, and independently. This is only possible when students know how to set personal goals. Students apply their acquired knowledge and skills in data science and from the broad range of elective topics in business, health, environmental studies, or social sciences. Their master thesis project starts with the identification of a suitable and relevant research question and preparatory literature searches, along with the design and implementation of data science research, its documentation, discussion, interpretation, and communication with the scientific community and perhaps beyond.

This module consists of two components, an independent thesis, and an accompanying seminar. The thesis must be supervised by a Constructor University faculty member and must be documented as a comprehensive written thesis, including an introduction, a justification of the methods, results, a discussion of the results, and conclusions. The seminar provides students with the opportunity to present, discuss, and justify their and other students' approaches, methods, and results at various stages of their research, to practice these skills, to improve their academic writing, to reflect on formative feedback, and thereby, to grow personally and professionally.

Intended Learning Outcomes

On completion of this module, students will be able to

1. comprehensively understand data science research at a professional level
2. master core data science techniques and tools
3. independently design and undertake ambitious research projects within a set period of time
4. draw scientific conclusions that also consider social and ethical aspects
5. constructively respond to debate and criticism
6. develop, formulate, and advance data science solutions, and defend these through arguments
7. formulate a future research proposal that can also serve as a funding proposal
8. write a research thesis that can be submitted to a scientific publication venue, or used as a project report for a funding agency or industrial client
9. effectively communicate with specialists and non-specialist audiences

Usability and Relationship to other Modules

The master thesis allows students to specialize and gain expertise in one of the many fields in data science. It usually builds on topics discussed in the core or elective modules of the program and exploits methodological knowledge and applied experiences from the methods and discovery modules.

Examination Type: Module Examination

Assessment Component 1: Thesis

Length: approx. 15,000 words
Weight: 80%

Scope: All intended learning outcomes, mainly 1–6.

Assessment Component 2: Oral defense (presentation) Duration: approx. 15–30 minutes
Weight: 20%

Scope: The presentation focuses mainly on ILOs 6 and 7, but, by the nature of these ILOs, also touches on the others.

Completion: This module can be passed with an assessment-component weighted average grade of 45% or higher.

Two separate assessments are justified by the size of the module and the fact that the justification of solutions to problems and arguments (ILO 6) and discussion (ILO 7) should at least have verbal elements. The weights of the assessments are commensurate with the sizes of the respective module components.

4 DSSB Program Regulations

4.1 Scope of These Regulations

The regulations in this handbook are valid for all students who entered the DSSB graduate program at Constructor University in Fall 2023. In case of conflict between the regulations in this handbook and the general policies for master studies, the latter shall apply (see Academic policies | Constructor University

In exceptional cases, certain necessary deviations from the regulations of this study handbook might occur during the course of study (e.g., change of the semester sequence, assessment type, or the teaching mode of modules).

In general, Constructor University reserves therefore the right to change or modify the regulations of the program handbook also after its publication at any time and in its sole discretion.

4.2 Degree

Upon successful completion of the program, students are awarded a Master of Science (MSc) degree in Data Science in Society and Business.

4.3 Graduation Requirements

In order to graduate, students need to obtain 120 CP. In addition, the following graduation requirements apply:

- In each module, students need to obtain a minimum CP, as indicated in Chapter 2 of this handbook.
- Students need to complete all mandatory components of the program, as indicated in Chapter 2 of this handbook.

5 Appendices

5.1 Intended Learning Outcomes Assessment-Matrix

Data Science for Society and Business (MSc.)					CORE: Digital Soc and Fut Econ	CORE: Data Science Concepts	CORE: Digital Public Spheres	CORE: Digital Business Mod & Func	CORE: Digital Transf and Innovation	CORE: AI in Business and Society	Methods: Data Science Tools	Methods: Text Analysis and NLP	Methods: Vis Comm and Data Story T	Discovery: Current Top and App in DSSB	Discovery: Data Science Lab	Discovery: Capstone Project	CAREER: Comm and Present Skills	CAREER: Ethics and Info Rev	CAREER: IT-Law	CAREER: Language	Society and Business Track	Advanced Data Science Track	Environment and Health Track	Internship	Masster Thesis
Semester					1	1	2	2	3	3	1	2	3	1	2	3	1	3	2	1-3	1-3	1-3	1-3	3	4
Mandatory/ Mandatory elective					m	m	m	m	m	m	m	m	m	m	m	m	m	m	me	me	me	me	me	me	m
Credits					5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	0-15	0-15	0-15	10	30
	Competencies*																								
Program Learning Outcomes	**A**	**E**	**P**	**S**																					
Identify, analyze, interpret, and critically assess the social (e.g. business, economic, political) causes and consequences of the digital transformation of societies;	x		x	x	x		x	x	x	x						x		x	x		x				x
Academically reflect and evaluate the legal and ethical implications surrounding privacy, data sharing, algorithmic decision making, and new business models in various digitized	x	x	x	x	x		x	x	x	x					x	x		x	x		x				x
Combine data science concepts and put them into practice by developing and designing state-of-the-art applications;	x	x		x		x	x	x	x	x	x	x	x	x	x	x					x	x	x	x	x
Develop scientific and professional solutions for social, ecological, economic, health, scientific, and political problems;	x	x	x	x	x		x	x	x	x		x	x	x	x	x		x	x		x	x	x	x	x
Creatively and convincingly solve research implementations problems;	x	x		x				x		x		x	x	x	x	x			x		x	x	x	x	x
learn programming and implementation in at least one computer language (R or Python) and acquire at least basic skills in the other;	x	x		x							x	x	x	x	x	x					x	x	x	x	x
Use state-of-the-art methods of digital data mining from the internet and other sources;	x	x								x	x	x	x	x	x	x					x	x	x	x	x
Efficiently and securely manage social media and business data;	x	x		x				x		x	x	x	x	x		x					x	x	x	x	x
Deliberately choose between, adapt, and potentially develop statistical models for 'big data' further;	x	x		x		x						x	x	x		x					x	x	x	x	x
Elaborately command analytical, critical, and synthesizing quantitative skills to correctly model and interpret scientific results, to make valid predictions, and to derive thoughtful conclusions and interventions for pressing social and business problems;	x	x	x	x		x				x	x	x	x	x	x	x					x	x	x	x	x
Apply innovative writing, communication, presentation techniques, and state-of-the-art visualization tools to effectively and convincingly reach out to a scientific and non-scientific audience;		x	x	x	x			x		x		x		x	x	x	x	x	x		x	x	x	x	x
Use efficiently and effectively online and offline material to boost self-learning and time-management skills to sharpen one's professional expertise, and to stay updated in a fast-developing		x	x	x	x	x	x	x	x	x	x	x		x	x	x		x	x		x	x	x	x	x
Function very well in an international and diverse working environment;		x	x	x	x	x	x	x	x	x	x			x	x	x	x	x	x	x	x	x	x	x	
Adhere to and defend ethical, scientific, and professional standards;	x		x	x	x		x	x	x	x	x	x		x	x	x		x	x		x	x	x	x	x
Make valuable contributions to society and business;		x	x	x	x		x	x	x	x				x	x	x	x	x	x	x	x	x	x	x	x
Grow personally to a responsible, smart, and resilient researcher, leader and collaborator;		x	x	x	x	x	x	x	x	x				x	x	x	x	x	x	x	x	x	x	x	x
take on an ambitious academic, business, or professional career in thriving digital areas.		x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x
Assessment Type																									
Oral examination																				x					x
Written examination					x	x														x		x	x		
Essay																				x					
Project assessment															x						x	x			
Term paper							x	x	x									x	x		x	x	x		
Project Report										x	x	x	x	x		x					x	x		x	
Poster presentation																									
Presentation																	x			x	x		x		
Various																									
Thesis																									x

*Competencies: A-scientific/academic proficiency; E-competence for qualified employment; P-development of personality; S-competence for engagement in society

Data Science for Society and Business (MSc.)					Cybercriminology	Introduction to Computational Social Science	Smart Cities and Transportation Concepts	Sustainability Economics	Principles of Consulting	Data Analytics	Data Mining	Introduction to Data Management with Python	Machine Learning	Geoinformatics	Geo-Information Lab	Modeling and Analysis of Complex Systems	Network Approaches in Biology and Medicine
Semester					1/ 3	2	1/ 3	1/ 3	1/ 3	1/ 3	2	3	2	1/ 3	2	1/ 3	1/ 3
Mandatory/ Mandatory elective					me	me	me	me	me	me	me	me	me	me	me	me	me
Credits					5	5	5	5	5	5	5	5	5	5	5	5	5
	Competencies*																
Program Learning Outcomes	**A**	**E**	**P**	**S**													
Identify, analyze, interpret and critically assess the social (e.g. business, economic, political) causes and consequences of the digital transformation of societies;	x		x	x	x	x	x	x									
Academically reflect and evaluate the legal and ethical implications surrounding privacy, data sharing, algorithmic decision making, and new business models in various digitized sectors;	x	x	x	x	x	x	x	x	x								
Combine data science concepts and put them into practice by developing and designing state-of-the-art applications;	x	x		x	x	x	x		x	x	x		x	x	x	x	x
Develop scientific and professional solutions for social, ecological, economic, health, scientific, and political problems;	x	x	x	x	x	x	x	x					x	x	x	x	x
Creatively and convincingly solve research implementations problems;	x	x		x	x	x	x	x		x	x		x	x	x	x	x
Program well in at least one computer language;	x	x		x		x				x	x	x	x	x	x	x	
Use state-of-the-art methods of digital data mining from the Internet and other sources;	x	x			x	x				x	x	x	x	x	x	x	
Efficiently and securely manage social media and business data;	x	x		x		x	x	x		x	x	x	x	x	x	x	
Deliberately choose between, adapt, and potentially develop statistical models for 'big data' further;	x	x		x		x	x			x	x	x	x	x	x	x	
Elaborately command analytical, critical, and synthesizing quantitative skills to correctly model and interpret scientific results, to make valid predictions, and to derive thoughtful conclusions and interventions for pressing social and business problems;	x	x	x	x		x	x	x	x	x	x		x	x	x	x	x
Apply innovative writing, communication, presentation techniques, and state-of-the-art visualization tools to effectively and convincingly reach out to a scientific and non-scientific audience;		x	x	x	x	x		x	x					x		x	
Use efficiently and effectively online and offline material to boost self-learning and time-management skills to sharpen one's professional expertise, and to stay updated in a fast-developing scientific area;		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Function very well in an international and diverse working environment;		x	x	x	x	x	x	x	x		x	x		x			
Adhere to and defend ethical, scientific, and professional standards;	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Make valuable contributions to society and business;		x	x	x	x	x	x	x	x				x	x		x	x
Grow personally to a responsible, smart, and resilient researcher, leader and collaborator;		x	x	x	x	x	x	x		x	x		x	x		x	x
take on an ambitious academic, business, or professional career in thriving digital areas.		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Assessment Type																	
Oral examination																	
Written examination												x	x			x	
Project report							x			x							
Project assessment												x					
Term paper					x	x		x						x	x		
Project Report									x		x						
Poster presentation																	
Presentation								x							x		x

Figure 3: Intended Learning Outcomes Assessment-Matrix