Technische Universität Braunschweig

Welcome to Data Science @ TU Braunschweig!

www.tu-braunschweig.de/data-science

https://www.youtube.com/watch?v=vh0_IOrw3Fw

Technische Universität Braunschweig

84	Study Programms
3.600	First Year Students
18.500	Students
120	Institutes
2.300	Researchers
3.800	Total Staff

Europe‘s Most Active Research Area

THÜNEN

3 LANDESMUSEEN

PTB

DLR

JKI
Julius Kühn-Institut

Technische Universität Braunschweig

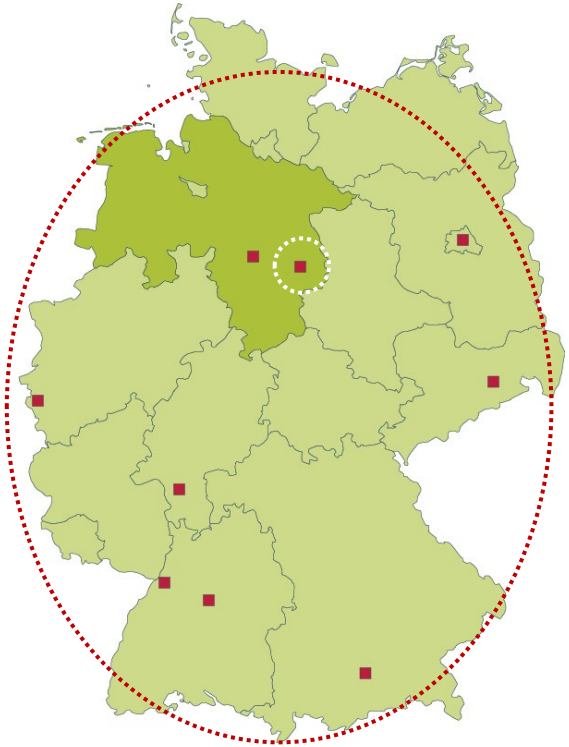
DSMZ

HERZOG AUGUST BIBLIOTHEK
WOLFENBÜTTEL

Fraunhofer

HELMHOLTZ
ZENTRUM FÜR
INFEKTIONSFORSCHUNG

GEORG ECKERT
INSTITUT



Data Science @ TU Braunschweig

- Foundational Master Programme in Mathematics and Computer Science
- Innovative Application Areas in Core Research Areas of TU Braunschweig
- International Master Programme – Fully taught in English
- Mentoring Concept
- Flexible Choice of Modules
- 30 – 40 Study Places per Year

Data Science - Relevance

- **Bitkom e.V.** Study of 2015
  - 48% of all companies generate value from data analyses.
  - 59% of all companies complain about the lack of data analysis specialists.
  - The added value of data analysis extends over all phases of the value chain.

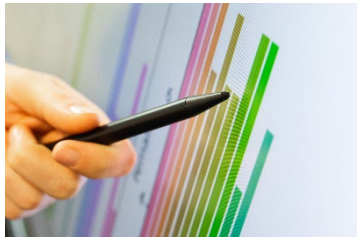
- **Simple Message:**

- **Harvard Business Review: Data Scientist is the Sexiest Job of the 21st Century!**

Skills and Competencies

- Graduates as **Master of Data Science** can

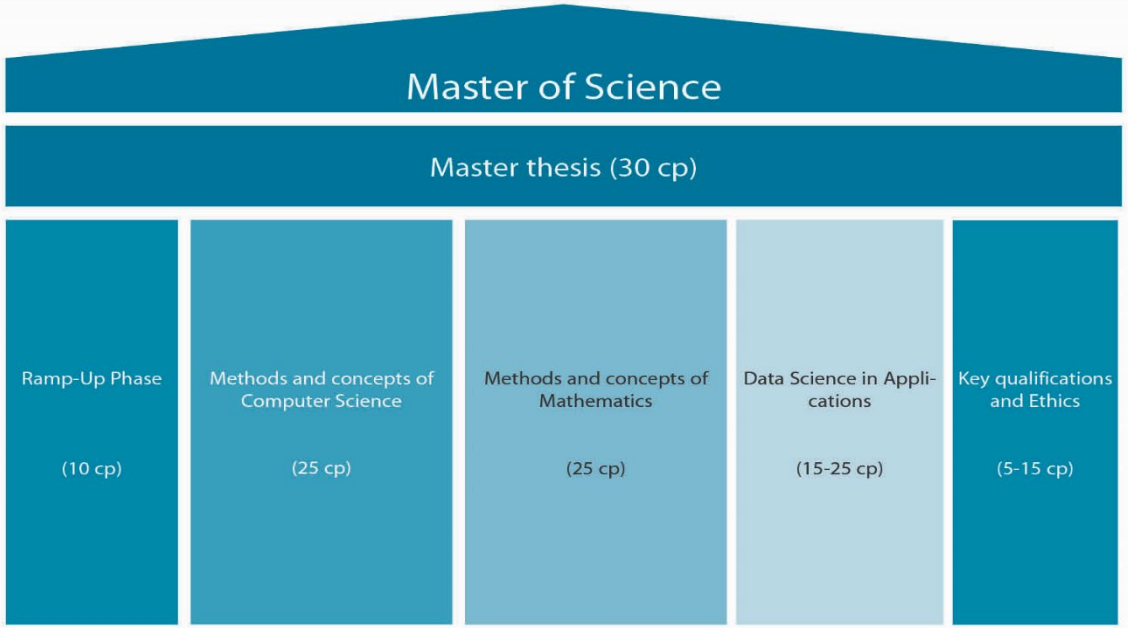
  - Use Methods of Data Acquisition, Data Integration and Data Management efficiently
  - Select Analysis Methods competently and adapt it to the Special Requirements of an Application
  - Evaluate and assess the Expressiveness of Analysis Methods and Results
  - Lead Data Projects in Companies and effectively manage Corporate Decision Processes



- **Simply: Data Science = Mathematics + Computer Science + Applications**

Design and Structure of the Study Program (120 Credits)

- 3 Core Areas:
  - 25 Credits **Mathematics**
  - 25 Credits **Computer Science**
  - 15-25 Credits **Applications**
- Application Areas
  - Biology, Chemistry, Pharmacy
  - Medicine
  - Engineering
  - Image and Signal Processing
- Mandatory seminar and lab courses
- Optional research project

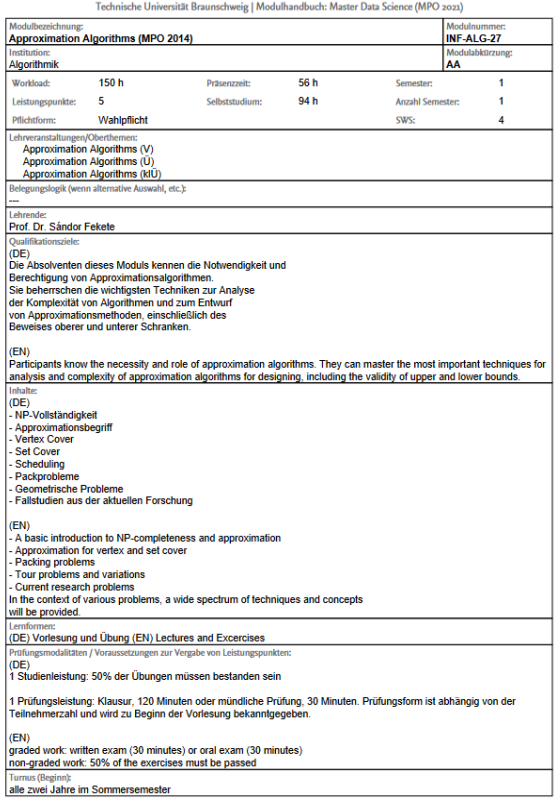


Modularization of the Degree Program

The course contents taught in the individual areas are combined into modules. A module consists of courses with related content.

Example "Approximation Algorithms": Excerpt from the module guide for the Examination Regulations

(=> see study program website "Documents“ Module Guide)



Technische Universität Braunschweig | Modulhandbuch: Master Data Science (MPO 2021)

Modulbezeichnung: Approximation Algorithms (MPO 2014)				Modulnummer: INF-ALG-27	
Institution: Algorithmik				Modulabkürzung: AA	
Workload:	150 h	Präsenzzeit:	56 h	Semester:	1
Leistungspunkte:	5	Selbststudium:	94 h	Anzahl Semester:	1
Pflichtform:	Wahlpflicht			SWS:	4

Lehrveranstaltungen/Oberthemen:
Approximation Algorithms (V)
Approximation Algorithms (Ü)
Approximation Algorithms (klÜ)

Belegungslogik (wenn alternative Auswahl, etc.):

Lehrende:
Prof. Dr. Sándor Fekete

Qualifikationsziele:
(DE)
Die Absolventen dieses Moduls kennen die Notwendigkeit und Berechtigung von Approximationsalgorithmen.
Sie beherrschen die wichtigsten Techniken zur Analyse der Komplexität von Algorithmen und zum Entwurf von Approximationsmethoden, einschließlich des Beweises oberer und unterer Schranken.

(EN)
Participants know the necessity and role of approximation algorithms. They can master the most important techniques for analysis and complexity of approximation algorithms for designing, including the validity of upper and lower bounds.

Inhalte:
(DE)
- NP-Vollständigkeit
- Approximationsbegriff
- Vertex Cover
- Set Cover
- Scheduling
- Packprobleme
- Geometrische Probleme
- Fallstudien aus der aktuellen Forschung

(EN)
- A basic introduction to NP-completeness and approximation
- Approximation for vertex and set cover
- Packing problems
- Tour problems and variations
- Current research problems

In the context of various problems, a wide spectrum of techniques and concepts will be provided.

Lernformen:
(DE) Vorlesung und Übung (EN) Lectures and Excercises

Prüfungsmodalitäten / Voraussetzungen zur Vergabe von Leistungspunkten:
(DE)
1 Studienleistung: 50% der Übungen müssen bestanden sein

1 Prüfungsleistung: Klausur, 120 Minuten oder mündliche Prüfung, 30 Minuten. Prüfungsform ist abhängig von der Teilnehmerzahl und wird zu Beginn der Vorlesung bekanntgegeben.

(EN)
graded work: written exam (30 minutes) or oral exam (30 minutes)
non-graded work: 50% of the exercises must be passed

Turnus (Beginn):
alle zwei Jahre im Sommersemester

Modules in Mathematics Core

- **Optimization:** Discrete Optimization, Dynamic Optimization, Polynomial Optimization, Optimization in Machine Learning, Algorithms and Complexity for Quantum Computing, …
- **Statistics:** Statistical Learning, Risk and Extreme Value Theory, Non-parametric Statistics, Time Series Analysis, Statistical Methods, …
- **Numerics:** Model Reduction, Numerical Analysis and Learning from Data, …
- **Applied Analysis and Algebra:** Inverse Problems, Computer Algebra, Machine Learning with Neural Networks, Introduction to Quantum Information Theory, Mathematical Foundations of Data Science, Mathematical Foundations of Information Theory and Coding Theory, …

Modules in Computer Science Core

- **Algorithmics:** Online Algorithms, Approximation Algorithms, Computational Geometry, Graphs Geometry and Algorithms, …
- **Machine Learning:** Foundations of Machine Learning, Pattern Recognition, Machine Learning for IT-Security, Deep Learning Lab, …
- **Databases and Information Systems:** Data Warehousing and Data Mining, Information Retrieval und Web Search Engines, Knowledge-based Systems, …
- **Software Engineering:** Software Architecture, Software Quality, Python Lab, Project Management, …
- **Distributed Systems**: Cloud Computing, Replication and Consistency, …

Application Areas

- **Biology, Chemistry and Pharmacy:** Network Biology, System Biology, Immune Metabolism, Bioinformatics, Theoretical Chemistry, Chemometrics, …

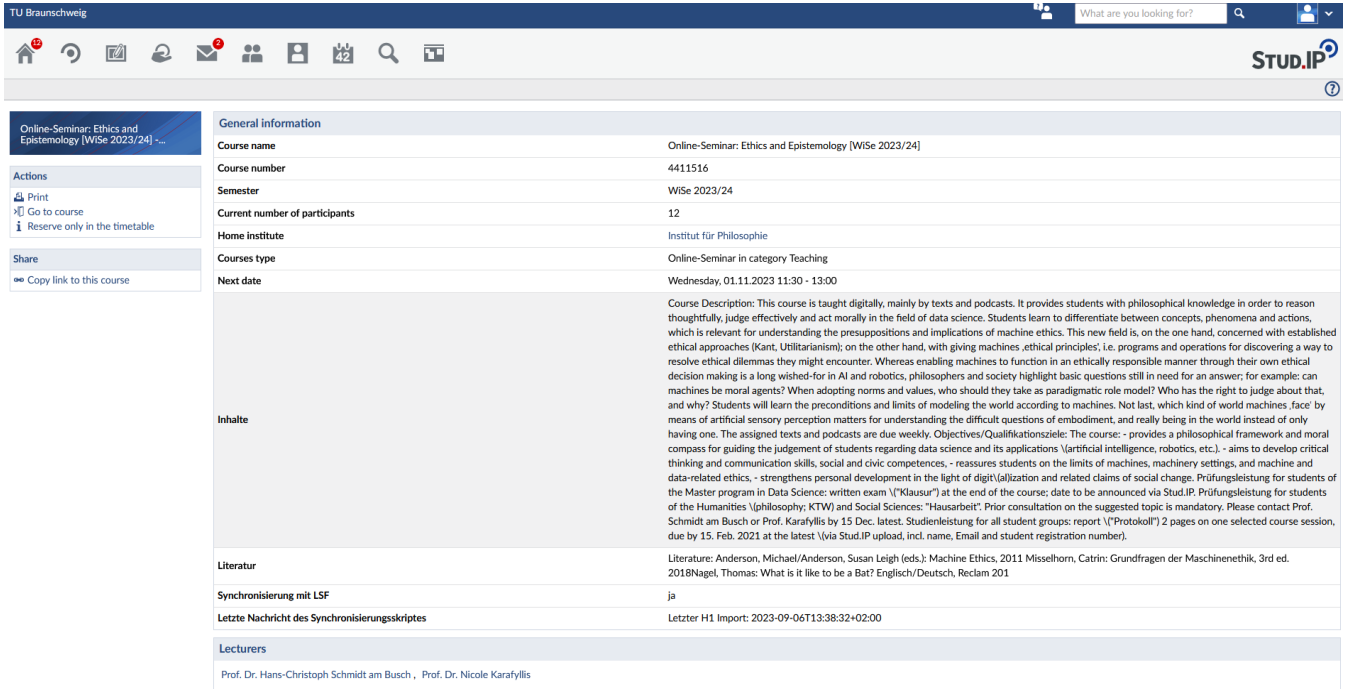
- **Medicine:** Biomedical Data Analysis, Accident Informatics, Health-Enabling Technologies, Biomedical Image and Signal Analysis, …

- **Data Science in Engineering:** Deep Learning for Remote Sensing, Machine Learning, Coastal Engineering, Railway Timetabling, Fundamentals of Turbulence Modeling, Ecological Modeling, Data-driven Material Modeling, …

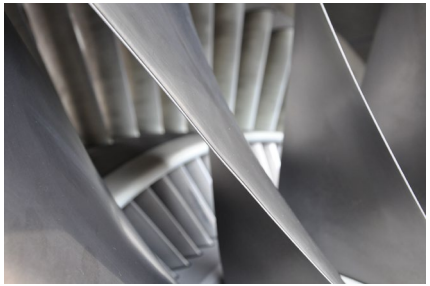
- **Image and Signal Processing:** Speech Dialogue Systems, Mathematical Image Processing, Digital Signal Processing, Computer Vision and Machine Learning, Deep Learning for Quantum and Nano Science, Computer Lab Pattern Recognition, …

Area „Key Qualifications and Ethics“ (5-15 CP)

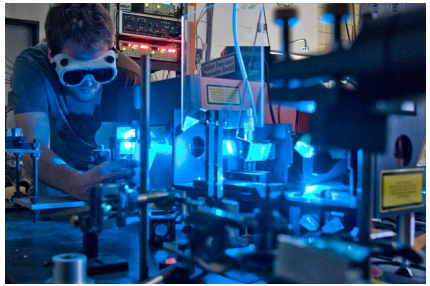
- modules (**compulsory module “Ethics and Epistemology” 5 CP**) provide students with interdisciplinary qualifications → course “**Ethics and Epistemology” only available in winter semester**
    - *Future Data Scientists must be able to reflect on the ethical implications of their actions and must be able to recognize and interpret social and technical problems.*
- additional credit points can be selected from the overall program (**pool**) of interdisciplinary courses or the Language Center (max. 8 CP)
- excludes courses in computer science, mathematics, and applications, as well as events of the sports center



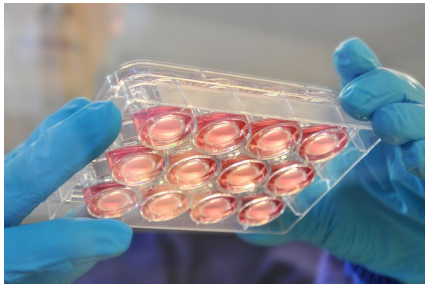
Core Research Areas @ TUBS



Mobility



Metrology



Infections & Therapeutics

Future Cities

Your Rights and Obligations: The Examination Regulations

- The general and special examination regulations for the Data Science degree program are available on the program's website.
- Please read these rules carefully so that there won't be any "unpleasant surprises" later.
- Where can I find the Examination Regulations: Program Websites

https://www.tu-braunschweig.de/en/data-science/documents

Duration of Study and Credit Points

Duration of study:

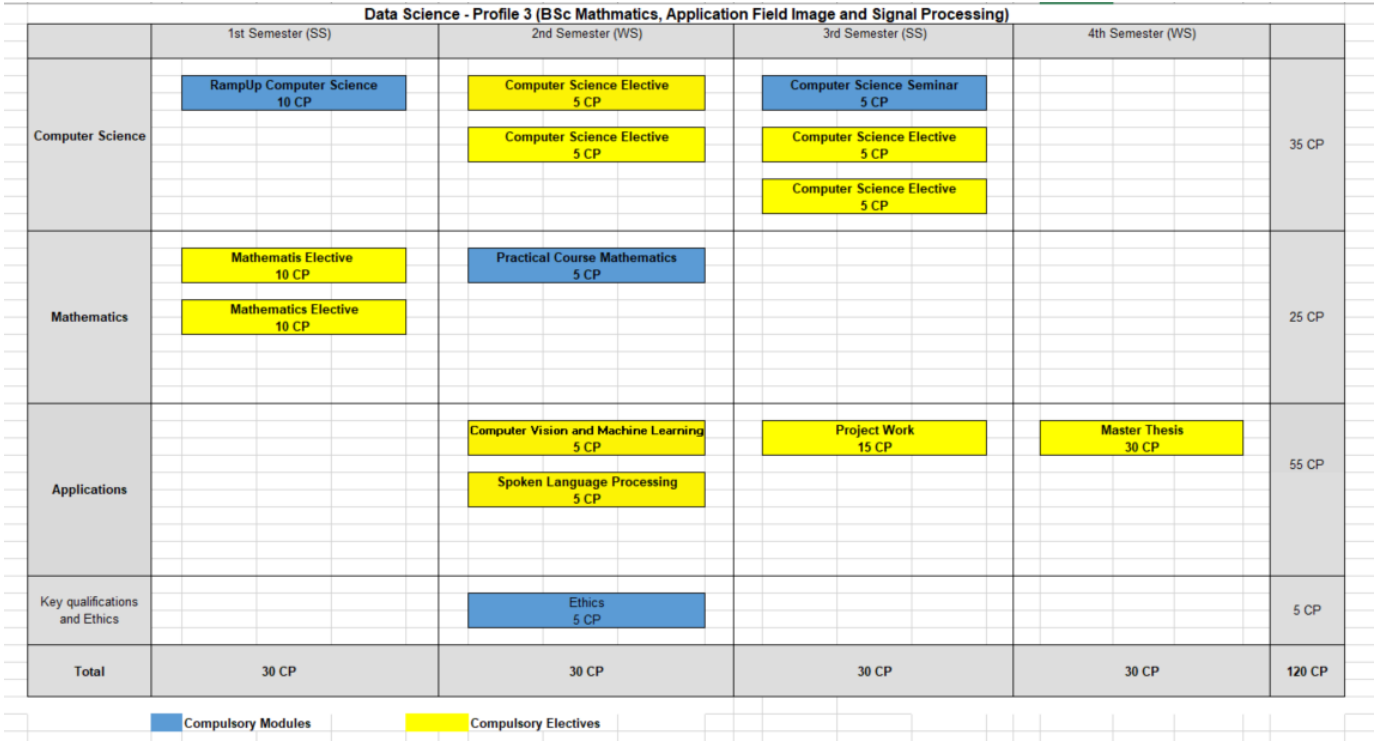
- Master Data Science: 4 semester

Credit point system:

- 1 CP (Credit Point) = Workload 25-30 hours
- 30 CP should be achieved per semester

- 120 CP’s are required for successful completion of your studies.

Sample Study Plan: Application Field Image and Signal Processing



Data Science - Profile 3 (BSc Mathmatics, Application Field Image and Signal Processing)

	1st Semester (SS)	2nd Semester (WS)	3rd Semester (SS)	4th Semester (WS)	
Computer Science	RampUp Computer Science 10 CP	Computer Science Elective 5 CP Computer Science Elective 5 CP	Computer Science Seminar 5 CP Computer Science Elective 5 CP Computer Science Elective 5 CP		35 CP
Mathematics	Mathematis Elective 10 CP Mathematics Elective 10 CP	Practical Course Mathematics 5 CP			25 CP
Applications		Computer Vision and Machine Learning 5 CP Spoken Language Processing 5 CP	Project Work 15 CP	Master Thesis 30 CP	55 CP
Key qualifications and Ethics		Ethics 5 CP			5 CP
Total	30 CP	30 CP	30 CP	30 CP	120 CP

Compulsory Modules Compulsory Electives

Sample Study Plan: Application Field Data Science in Engineering

Data Science - Profile 4 (BSc Mathematics/Physics, Application Field Data Science in Engineering)

	1st Semester (SS)	2nd Semester (WS)	3rd Semester (SS)	4th Semester (WS)	
Computer Science	RampUp Computer Science 10 CP	Computer Science Elective 5 CP Computer Science Elective 5 CP	Computer Science Seminar 5 CP Computer Science Elective 5 CP Computer Science Elective 5 CP		35 CP
Mathematics	Mathematics Elective 10 CP Mathematics Elective 10 CP	Practical Course Mathematics 5 CP		Master Thesis 30 CP	55 CP
Applications		Basic Coastal Engineering 6 CP Introduction to Finite Elements 5 CP	Ecological Modeling 6 CP Modeling 5 CP		22 CP
Key qualifications and Ethics		Ethics 5 CP	Key qualifications 3 CP		8 CP
Total	30 CP	31 CP	29 CP	30 CP	120 CP

Compulsory Modules Compulsory Electives

Sample Study Plan: Application Field Medicine

Data Science - Profile 1 (BSc Computer Science, Application Field Medicine)

	1st Semester (WS)	2nd Semester (SS)	3rd Semester (WS)	4th Semester (SS)	
Computer Science	Computer Science Elective 5 CP Computer Science Elective 5 CP Computer Science Elective 5 CP	Computer Science Elective 5 CP	Computer Science Seminar 5 CP	Master Thesis 30 CP	55 CP
Mathematics	RampUp Mathematics 10 CP	Mathematics Elective 10 CP	Mathematics Elective 10 CP Practical Course Mathematics 5 CP		35 CP
Applications		Med-meth. Specialization 1 5 CP Accident Informatics 5 CP Biomedical Image & Signal Analysis 5 CP	Med.-meth. Specialization 2 5 CP		20 CP
Key qualifications and Ethics	Ethics 5 CP		Key qualifiacations 5 CP		10 CP
Total	**30 CP**	**30 CP**	**30 CP**	**30 CP**	**120 CP**

Compulsory Modules Compulsory Electives

Sample Study Plan: Application Field Biology, Chemistry, Pharmacy

Data Science - Profile 2 (BSc Bioinformatics, Application Field Biology, Chemistry, Pharmacy)

	1st Semester (WS)	2nd Semester (SS)	3rd Semester (WS)	4th Semester (SS)	
Computer Science	Computer Science Elective 5 CP Computer Science Elective 5 CP	Computer Science Elective 5 CP	Practical Course Computer Science 5 CP Computer Science Elective 5 CP		25 CP
Mathematics	RampUp Mathematics 10 CP	Mathematics Elective 10 CP Mathematics Elective 10 CP	Mathematics Elective 5 CP		35 CP
Applications	Network Biology 5 CP	Numerical Ecology (Seminar) 5 CP	Project Work 15 CP	Master Thesis 30 CP	55 CP
Key qualifications and Ethics	Ethics 5 CP				5 CP
Total	30 CP	30 CP	30 CP	30 CP	120 CP

Compulsory Modules Compulsory Electives

What do I have to consider at the beginning of my studies? 1/2

Mentoring and Study Planning:

At the beginning of the program, each student is assigned a mentor from the faculty of the Department of Computer Science or the Department of Mathematics by the Data Science Examination Committee.

- please get in touch with your mentor (within the first two weeks of lectures)
- create a study plan together
- submit the countersigned study plan before the start of the first examination registration period (before 01.06.2024) to the Examination Office (pa-mathe@tu-braunschweig.de / Janine Werner)

What do I have to consider at the beginning of my studies? 2/2

Joint RampUp Phase in the first week of the semester

These events are compulsory. Please make sure you attend both dates:

- **Wednesday, 03.04.2024**, 09:45 – 11:15 am in **PK 3.4**, *Prof. Tim Kacprowski & Prof. Wolf-Tilo Balke* "Data Science Project LifeCycle“

- **Thursday, 04.04.2024,** 11:30 – 13:00 am in **LK 19a1,** *Muhammad Usman* "German University System & Community Management“ + "Introduction to Academic Work and Plagiarism"

  - https://campusplan.tu-braunschweig.de/

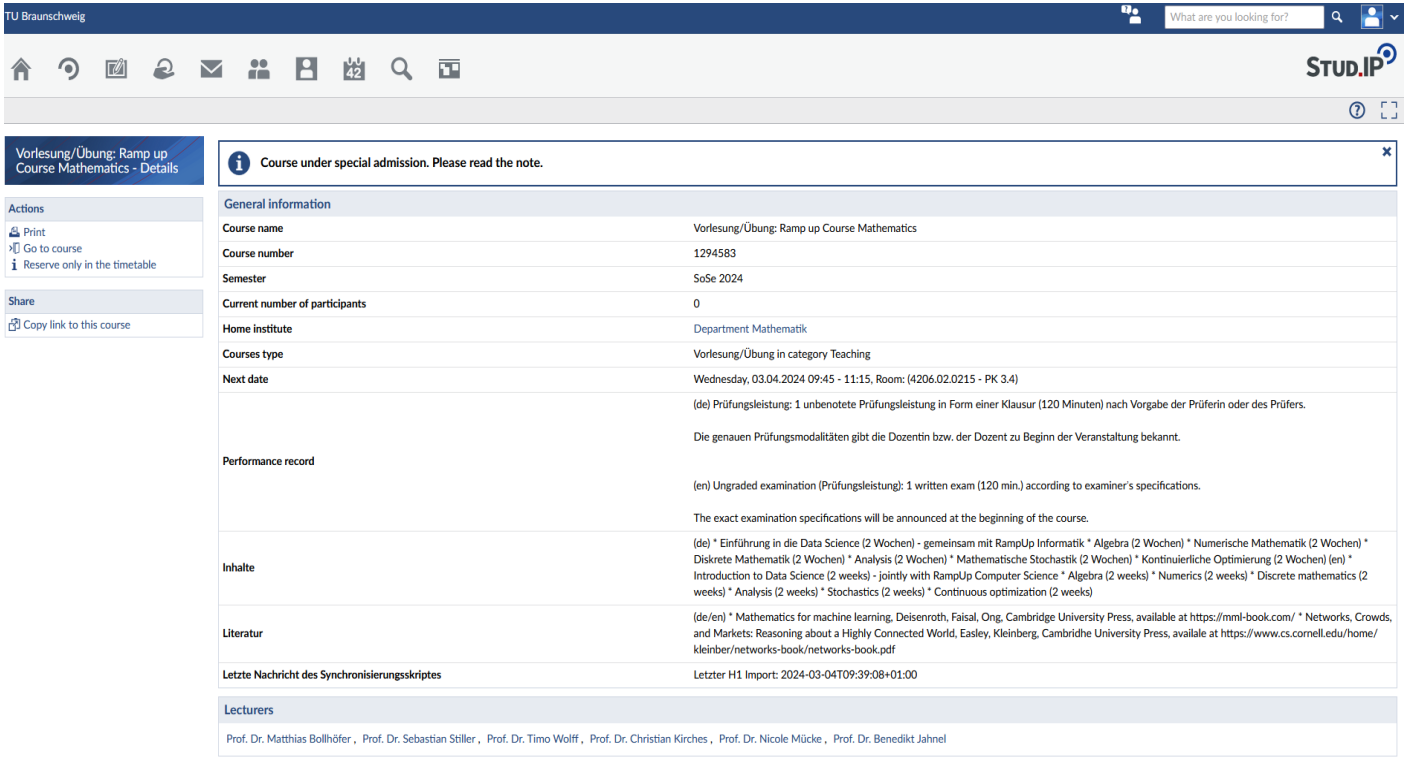
Starting from the 2nd week of the semester, the Mathematics and Computer Science RampUp will again take place separately. Further information about the two modules can be found here:

further information about the following weeks:

- Computer Science RampUp
- Mathematics RampUp

Stud.IP – The teaching and learning platform of TU Braunschweig

- central tool for the digital accompaniment of classroom courses
- it provides information on the organisation of teaching and serve as a communication platform
- registration for courses
- contact to the lecturers
- information and access to the courses
- access to the files of the courses
- create your own study groups



Stud.IP – Support

Our support team is your central address for all questions and problems concerning Stud.IP. We are at your disposal for questions concerning the daily use and support you in the use of tools and plugins as well as in the implementation of didactic concepts.

Support Times

Please refer to the following web link: https://www.tu-braunschweig.de/en/studip

Contact

✉ studip@tu-braunschweig.de

☎ +49 531 391-14040

Exam registration

Exam registration:

- online: https://connect.tu-braunschweig.de
- registration period in summer semester: **01.06.2024 – 30.06.2024**
- written exam registration: only for additional exams and other exceptions

Cancelling exam registrations:

- written exam: until penultimate working day before exam (Saturday and Sunday = no working day)
- oral exam: until one week before exam (please use deregistration form)
- homework (term paper): until 15.02. (winter semester), 15.08. (summer semester)

Seminar:

- registration: until day of kick-off event of the particular semester
- withdrawal: until 2 weeks after beginning of lectures in that particular semester

Mailinglist Data Science

In the study it is essential to be always quickly supplied with the most important information.

The central information channel for Data Science is **the mailing list.**

Please make sure that you are registered as a subscriber to the list with your TU mail address and that you receive the messages at the beginning of the semester.

- ***Mailinglist Data Science (ds-studs@lists.tu-braunschweig.de)***

Always stay up to date (Weblinks)

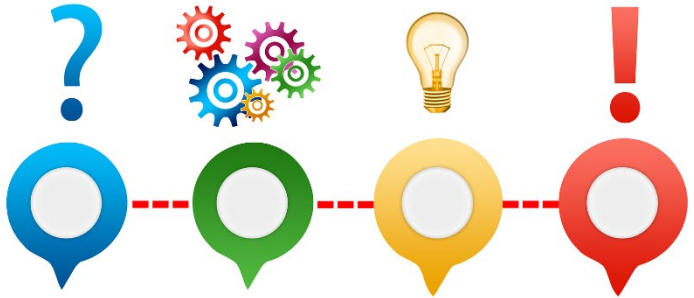
1. Programme-specific Part to the Examination Regulations Pertaining to the Data Science Master's Degree
2. Module Guide Summer Semester 2024
3. TU Connect
4. StudIP TU Braunschweig
5. Data Science First-Semester Students
6. Institutes
7. Contacts

Examination Office

Contact

Janine Werner

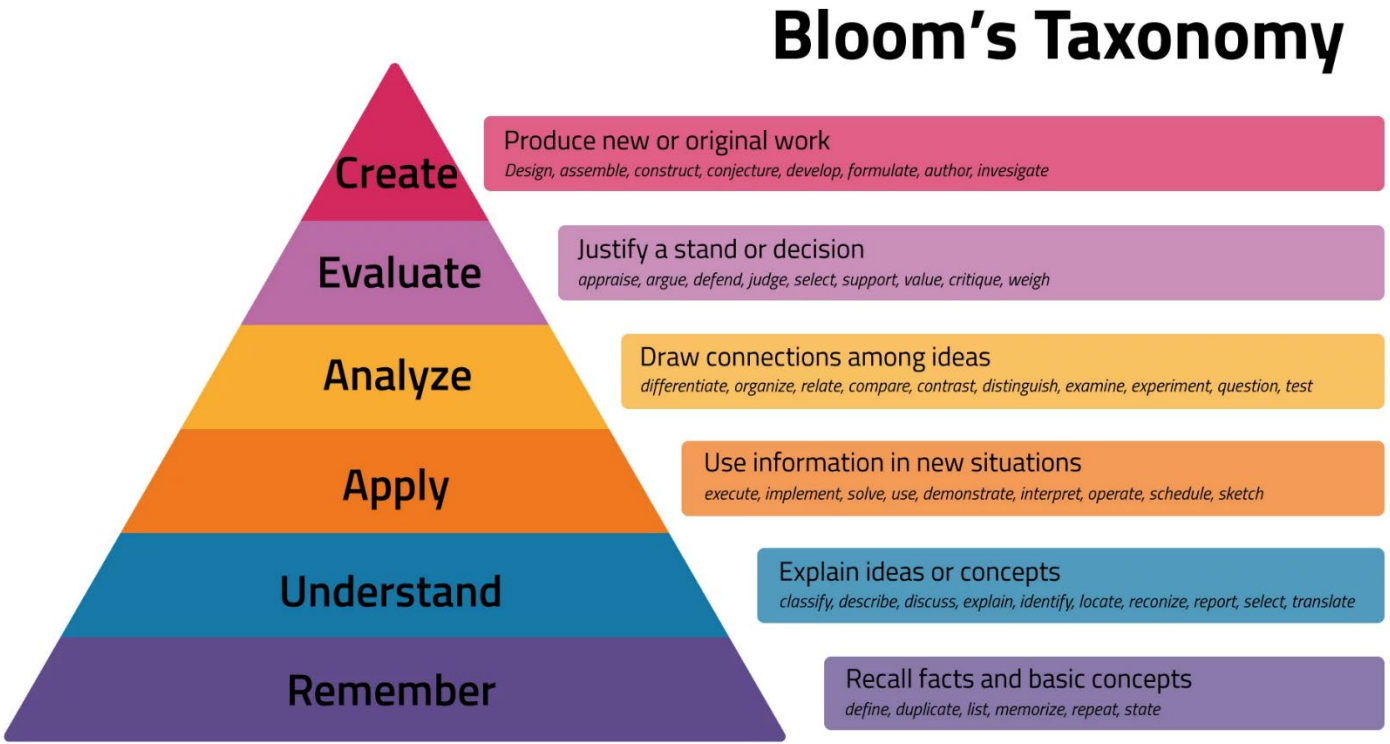
- Rebenring 58 A (1st floor)
- Room 117
- Phone: +49-531-391-2851
- Mail: pa-mathe@tu-braunschweig.de
- Office hours: By arrangement



Program Coordination and Study Guidance

Contact

Marvin Plagge

- Rebenring 58 A (1st floor)
- Room 124
- Phone: +49-531-391-2831
- Mail: ds-studium@tu-braunschweig.de
- Office hours: By arrangement

"German University System & Community Management“