Master's Programs in Mathematics

TUM Master's Days 2026

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Studying Mathematics

Mathematics @ TUM

- top address in mathematics
- wide variety of courses
- focus on applications
- specialized degree programs
- great reputation in the labor market
- great research opportunities
- English as main language of instruction

Degree Programs

General Characteristics

- four semester program
- 120 ECTS credits
- language: English
- mandatory internship
- exchange programs

Degree Programs

Mathematics in Science & Engineering

Mathematics in Data Science

Math. Finance & Actuarial Science

Mathematics

Math. in Science & Eng.

- Applied Analysis & Differential Equations
- Mathematical Modelling
- Scientific Computing
- Applications: Engineering, Health, Automotive, Computing, etc.

SIEMENS

KUKA

Linde

BMW

bertrandt

BRAINLAB

Infineon technologies

AIRBUS

Math. in Science & Eng.

Modules

- Analysis & Diff. Equations
- Numerics & Sc. Computing
- Optimization
- Case Studies
- Application subject (individual specialization)

Prerequisites

- BSc in Mathematics / Engineering (math. focus)
- Vector Analysis
- Nonlinear Optimization
- (Numerics of) Diff. Equations
- Programming Skills

Math. in Data Science

- Statistics, Data Analysis & Analytics, Optimization
- Machine Learning, Artificial Intelligence
- Data Engineering
- Distributed Computing
- Computer Science

Spotify

Google

amazon

zalando

Math. in Data Science

Modules

- Data Analysis
- Data Engineering
- Statistics, Optimization, Mathematics of Machine Learning
- Data Mining, AI, ML
- Database Systems, Cloud Computing

Prerequisites

- BSc in Mathematics / Informatics
- Algorithms and Data Structures
- Databases

Math. Fin. & Act. Science

- Finance, Risk, Portfolio Theory
- Insurance Mathematics
- Statistics, Probability Theory
- Econometrics
- Management

HypoVereinsbank
UniCredit Group

Bayern LB

Deutsche Bank

LV 1871

Goldman Sachs

Allianz

Münchener Rück
Munich Re Group

Math. Finance & Actuarial Science

Modules

- Specializiation: Math. Finance or Actuarial Science
- Probability Theory & Statistics
- Applied and Pure Mathematics
- Management

Prerequisites

- BSc in Mathematics
- Statistics
- Probability Theory (based on measure theory)

Mathematics

- wide variety of courses
- optional focus
- optional minor
  informatics, physics, economics, chemistry, life sciences

Mathematics

Modules

- Analysis & PDE
- Algebra & Geometry
- Probability
- Scientific Computing
- Optimization
- Biomathematics

Prerequisites

- BSc in Mathematics

Application & Prerequisites

Application & Prerequisites

- BSc in Mathematics
- good grades, $\geq$ 140 credits to apply
- qualifications: advanced math + specific modules
- letter of motivation
- language certificate (EN)
- document verification (Uni Assist)
- APS certificate (selected countries)

Additional Documents for Data Science

- BSc in Mathematics / Informatics
- qualifications: advanced math + informatics modules
- letter of motivation + essay
- language certificate (EN)
- GRE (selected countries)

Tuition Fees (non-EU)

- no fees for EU / EEA students
- no fees with German BSc
- fees: 6000,- € per semester
- merit scholarships
- waiver programs for students in need

Exchange Programs

- ERASMUS+, TUMExchange
- partner universities worldwide
- Austria, Belgium, Czech Republic, Denmark, Finland, France, Hungary, Iceland, Ireland, Italy, Netherlands, Norway, Portual, Slowenia, Spain, Sweden, Switzerland, Turkey, UK
- cooperation partners in Argentina, Brazil, Mexico, Canada, US, South Africa, China, India, Vietnam, Japan, Australia, …

Mathematics in Science & Engineering

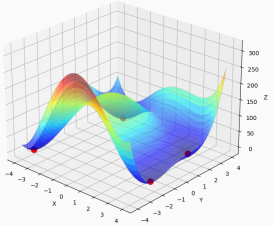
MScE =

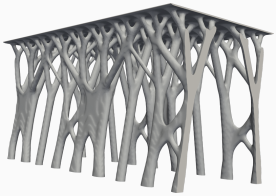
- **Applied mathematics lectures** ($\sim 30\,\%$) mostly from
  - Analysis
  - Numerics & Sc. Comp.
  - Optimization
- **Individual application subject** ($\sim 25\,\%$) mostly from
  - engineering
  - physics
- Master thesis about math. topic ($25\,\%$)
- Case Studies, internship, ...

  $\rightarrow$ *industrial experience!*

Applied maths modules

- **Abstract theory**
- **Analysis and proof techniques**
  - existence & uniqueness results
  - convergence & stability
  - optimality & sensitivity
- **Theoretical foundations of**
  - mathematical models
  - methods & algorithms





Application subject

- Individually discussed, by personal interests and career goals
- Clear, deep and real applicational thematic focus
- Module mix on Master level

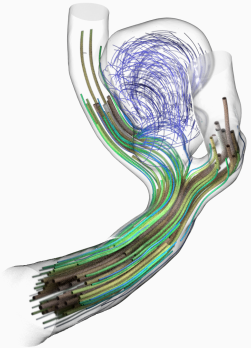
Goal

- Expertise in industrial field & competitiveness on job market
- Interdisciplinary experience & mathematical skill-set

→ *Research, Innovation, Analysis and Development of algorithms, methods, ...*

Application subject - Examples

- **Medical imaging/simulation technology**
  - CT & X-ray physics (*PH*)
  - Computer vision and image analysis (*IN*)
  - Biomedical physics/mechanics (*MW*)
- **Automotive technology**
  - Classical automotive engineering (*MW*)
  - Autonomous Driving (*IN*)
  - Electrical engineering / vehicles, batteries (*EI*)
  - Aerodynamics (towards race cars) (*MW*)



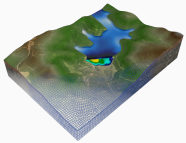
Graduate profile

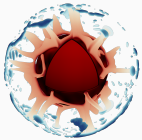
- Solving **real-world problems** from Sc. & Eng. with maths
- Deep knowledge in abstraction & mathematical modeling
- Collaboration in **interdisciplinary** teams
- Application specific master level

Modeling, Simulation & Optimization: From model-equation to HPC

Career prospects (examples)

- **Research & Development**
  - ☐ Automotive & Aerospace
  - ☐ Robotics & Semiconductors
- **(Simulation) Software development**
  - ☐ Fluid & Structural mechanics
  - ☐ Earth- & Climate science
  - ☐ Biochemistry & Medicine
- **Consulting & Optimization**
  - ☐ Energy-sector, Traffic/Logistics





Differentiation from other programs

-  **CSE:** ***Less*** HPC/performance, **more** numerical methods
-  **Engineering:** ***Less*** experiments, **more** simulations and math. modeling
-  **CoMe:** ***Less*** specific mechanics, **more** gen./fundamental methodology
  → *with individual field of concrete application*
-  **Pure Maths:** ***No*** number theory/algebra/topology, **same** applied maths

Mathematical Finance and Actuarial Science

MFAS =

- **Mathematical Finance, 14 ECTS** or 9 ECTS
  - Finanical Mathematics 1 (9), Financial Mathematics 2 (9)
  - Quatitative Risk Management (5)
- **Actuarial Science, 14 ECTS** or 9 ECTS
  - Insurance Mathematics 1 (9), Insurance Mathematics 2 (9)
  - Quatitative Risk Management (5)
- **Stochastics, 14 ECTS**
  - Stochastic Analysis (9), Markov Processes (9), Probability on Graphs (5)
  - Generalized Linear Models (9), Fundamentals of Math. Statistics (9), Stat. Learning (6), Comp. Statistics (5)

MFAS = (continued)

- **Mathematics, 9 ECTS**
  - Numerics, Optimization, Pure Math
- **Management, 6 ECTS**
  - Asset Management, Corporate Finance, Derivatives, Introduction to Deep Reinforcement Learning
- **Internship (6 ECTS), Seminar (3 ECTS), Interdisciplinary Foundations (4 ECTS)**
- **Master Thesis (30 ECTS)**
- **Competence Enhancement:** Probability Theory (if missing)

Prerequisites for MFAS: Advanced Math (at least 18 ECTS)

- Analysis 3 (9), Complex Analysis (5)
- Numerics of Differential Equations (9)
- Functional Analysis (9), Partial Differential Equations (9)
- Applied Regression (5), Statistical Computing (5)
- Markov Chains (5), Introduction to Optimization (9)

Prerequisites for MFAS: Stochastics (at least 18 ECTS)

- Introduction to Probability Theory and Statistics (9)
- Probability Theory (9)

Main Textbooks for Probability Theory:

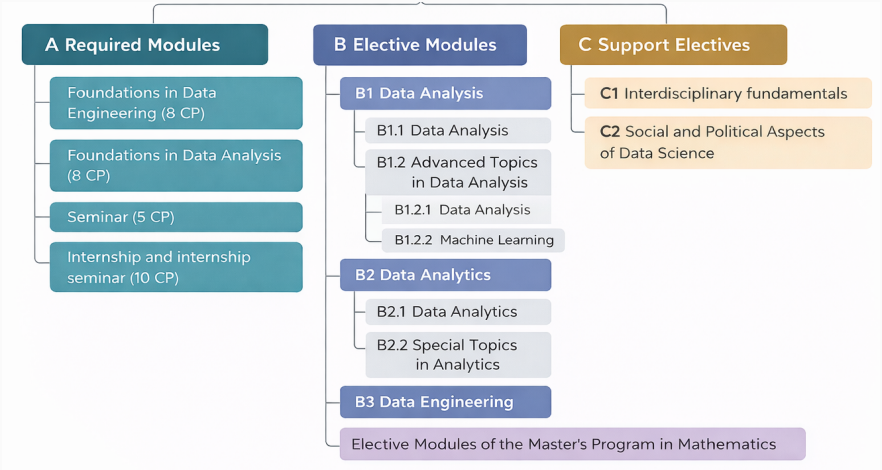
- Rick Durrett: Probability: Theory and Examples, Duxbury advanced series, third edition, 2005.
- Achim Klenke: Probability Theory: A Comprehensive Course, Springer, 2008.

Probability Theory: Course Content

- Existence of sequences of random variables,
- Kolmogorov's extension theorem, Borel-Cantelli lemmas,
- Kolmogorov's 0-1-law, weak and strong law of large numbers,
- Characteristic functions, weak convergence,
- Central limit theorem for L^2-random variables, Lindeberg-Feller,
- Conditional expectations,
- Martingales: Inequalities, convergence theorems, optional stopping theorem.

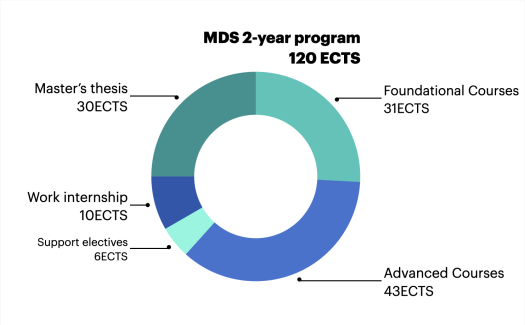
Mathematics in Math. in Data Science

MDS =


A Required Modules
Foundations in Data Engineering (8 CP)
Foundations in Data Analysis (8 CP)
Seminar (5 CP)
Internship and internship seminar (10 CP)
B Elective Modules
B1 Data Analysis
B1.1 Data Analysis
B1.2 Advanced Topics in Data Analysis
B1.2.1 Data Analysis
B1.2.2 Machine Learning
B2 Data Analytics
B2.1 Data Analytics
B2.2 Special Topics in Analytics
B3 Data Engineering
Elective Modules of the Master's Program in Mathematics
C Support Electives
C1 Interdisciplinary fundamentals
C2 Social and Political Aspects of Data Science

Distribution of CPs

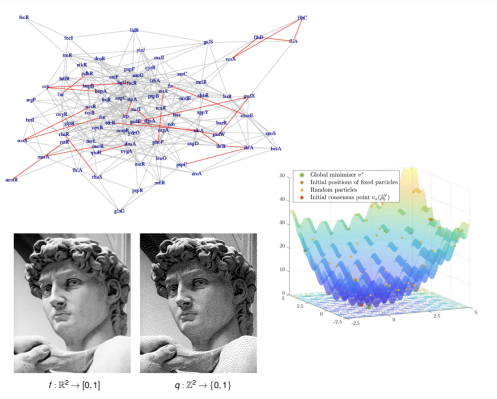
- **1st semester:**
  - Rewquired & foundational overview courses
- **2nd-3rd semester:**
  - Core training on the mathematical foundations and applied aspects of DS & AI
  - Advanced Seminar
  - Work Internship xx(evtl. at TUM Data Lab)
- **4th semester:**
  - Master's Thesis



Advanced Courses

MDS Program offers a great variety of specialization topics:

- machine learning
- numerical analysis
- optimization
- statistics
- topological data analysis
- various intersectional topics



MDS Program: People

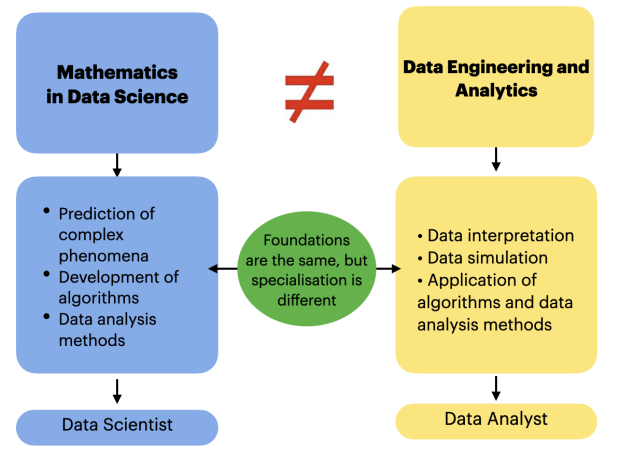
Prof. Dr. Felix Dietrich
Academic Program Director

Prof. Dr. Debarghya Ghoshdastidar
Study Program Director

Dr. Anna Veselovska,
Study Program Coordinator

Natalie Merk
Student Mentor

”MDS ” vs. ”DEA”


Mathematics in Data Science
≠
Data Engineering and Analytics
• Prediction of complex phenomena
• Development of algorithms
• Data analysis methods
Foundations are the same, but specialisation is different
• Data interpretation
• Data simulation
• Application of algorithms and data analysis methods
Data Scientist
Data Analyst

Application Process for MDS

Application period:

- Winter Term: Feb 1 to May 31
- Summer Term: Oct 1 to Nov 30

You can apply with:

- BS in Mathematics
- BS in Computer Science/ Informatics (with a minor in Mathematics)
- or BS in other comparable disciplines

Application Process for MDS

- **Application Evaluation in three Steps:**
  - S0: Formal & Qualification requirements
  - S1: Discipline-specific requirements
  - S2: Interview (in some cases)

Prerequisites for MDS: BS in Math

Bachelor's degree in Mathematics with minor in Computer Science

Minimum of 64 ECTS in Foundations in Mathematics:

-- Lineare Algebra 1 (MA0004), max. 9 ECTS
-- Lineare Algebra 2 und Diskrete Strukturen (MA0005), max 10 ECTS
-- Analysis 1 (MA0001), max. 9 ECTS
-- Analysis 2 (MA0002), max 9 ECTS
-- Analysis 3 (MA0003), max 9 ECTS
-- Introduction to Probability and Statistics (MA0009), max 9 ECTS
-- Introduction to Optimization (MA2012), max 9 ECTS

Minimum of 18 ECTSFoundations in Informatics/Computer Science:

-- Introduction to Computer Science (IN0001), 6 ECTS
-- Foundations of Algorithms and Data Structures (IN0007), max 6 ECTS
-- Foundations of Data Bases (IN0008), 6 ECTS
-- Foundations of Operating Systems and System Software (IN0009), max 6 ECTS
-- Foundations of Networks and Distributed Systems (IN0010), max 6 ECTS

Prerequisites for MDS: BS in CS

Bachelor's degree in Computer Science with minor in Mathematics

Minimum of 39 ECTS in Foundations in Mathematics:

-- Diskrete Strukturen Discrete Structures (IN0015), 8 ECTS
-- Analysis for Computer Science (MA0902), max 8 ECTS
-- Linear Algebra for Computer Science (MA0901), max 8 ECTS
-- Discrete Probability Theory (IN0018), max 6 ECTS
-- Introduction to Optimization (MA2012), max 9 ECTS

Minimum of 30 ECTS in Foundations in Informatics/Computer Science:

-- Introduction to Computer Science (IN0001), 6 ECTS
-- Foundations of Algorithms and Data Structures (IN0007), max 6 ECTS
-- Foundations of Data Bases (IN0008), 6 ECTS
-- Foundations of Operating Systems and System Software (IN0009), max 6 ECTS
-- Foundations of Networks and Distributed Systems (IN0010), max 6 ECTS

We wish you every success with your applications!

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Thank you for your attention!

Questions

Questions?

- Mathematics in Science and Engineering: Markus Muhr
- Mathematical Finance and Actuarial Science: Aleksey Min
- Mathematics in Data Science (incl. Admissions): Anna Veselovska
- Mathematics, general questions: Michael Ritter (main room)
- Admissions: Diana Conache

https://www.cit.tum.de/en/cit/studies/