

Case Studies 2025

Life Science Mathematics

Optimization

Scientific Computing

Christina Kuttler, Michael Ritter, Rainer Callies, Markus Muhr

Technical University of Munich, Department of Mathematics

06 February 2025

Welcome



About the course



What will you learn?

- ▶ apply mathematical skills to practical problems
- ▶ analyze and model problems
- ▶ evaluate solution techniques
- ▶ implement suitable algorithms
- ▶ assess solutions

What will you learn?

- ▶ work with practitioners
- ▶ experience real-world challenges
- ▶ communicate to different audiences
- ▶ outreach / science communication
- ▶ experience impact of your work

What will you learn?

- ▶ experience teamwork / team dynamics
- ▶ self / team management
- ▶ organization / documentation / communication
- ▶ presentation / writing skills

Successful Participation

- ▶ mandatory participation in central meetings
- ▶ in-person participation only
- ▶ active project work and contributions to project outcome
- ▶ active contributions to presentations and final report

Workload

▶ 10 ECTS ✦✦

Workload

- ▶ 10 ECTS ✦✦
- ▶ 300 hours total semester workload per person
- ▶ estimated workload: 20 hours per week

Workload

- ▶ 10 ECTS ✦✦
- ▶ 300 hours total semester workload per person
- ▶ estimated workload: 20 hours per week
- ▶ groups of 3-4 students

Grading

- ▶ project work
- ▶ project report
- ▶ poster
- ▶ presentation

All Projects

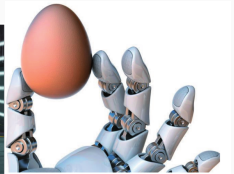
Optimization

- ▶ Inventory Routing (DO)
- ▶ District Heating Networks (DO)
- ▶ Trajectory Optimization in Learned Environments (NLO)
- ▶ Robust Bundle Adjustment for 3D Scene Reconstruction (NLO)

All Projects

Scientific Computing

- ▶ S1: High-Speed Driving with Predefined Level of Safety
- ▶ S2: Heat Transfer in Concentrated Solar Powerplant
- ▶ S3: Abort Landing in case of Uncertain Windshear
- ▶ S4: Virtual Wind Tunnel
- ▶ S5: Dynamic Deformation of an Elastic Robot Fingertip



Preliminaries



What do we expect?

- ▶ dedication
- ▶ open mindedness & creativity
- ▶ motivated by real-world challenges
- ▶ teamwork & communication
- ▶ **in-person participation over the whole semester**

Required courses

Optimization

- ▶ Introduction to Optimization (basic linear / nonlinear optimization)
- ▶ project specific skills

Required courses

Optimization

- ▶ Introduction to Optimization (basic linear / nonlinear optimization)
- ▶ project specific skills

... for Nonlinear Optimization

- ▶ Numerical Linear Algebra
- ▶ Nonlinear Optimization: Advanced
- ▶ Modern Methods of Nonlinear Optimization (optional)

Required courses

Optimization

- ▶ Introduction to Optimization (basic linear / nonlinear optimization)
- ▶ project specific skills

... for Discrete Optimization

- ▶ Integer / Discrete Optimization
- ▶ Combinatorial Optimization (optional)

Required courses

Scientific Computing

- ▶ Analysis, Linear Algebra & Discrete Structures
- ▶ Numerical analysis
- ▶ Numerics of differential equations (ordinary / partial)
- ▶ Nonlinear optimization & Optimal control (*dep. on the project*)
- ▶ Programming skills in (some of) *MATLAB, Python, C/C++, ...*

Required courses

Life Science Mathematics

- ▶ Analysis, Linear Algebra
- ▶ some course(s) in the area of Mathematical Biology, Nonlinear Dynamics etc.
- ▶ AND/OR some course(s) in Statistics
- ▶ helpful: some programming skills

Why should you do it?



Why should you do it?



Mathematics

Manage

Communicate

Why should you do it?

Mathematics

Manage

Communicate

- ▶ apply mathematical theory to real-world challenges

Why should you do it?

Mathematics

Manage

Communicate

- ▶ apply mathematical theory to real-world challenges
- ▶ project management, team organization

Why should you do it?

Mathematics

Manage

Communicate

- ▶ apply mathematical theory to real-world challenges
- ▶ project management, team organization
- ▶ communication and presentation skills

What to do next?



Application

- ▶ limited intake
- ▶ application until **17 March 2025**
- ▶ online form → website
- ▶ courses, skills, project ranking, preferred team members, etc.
- ▶ final allocation: **24 March to 07 April 2025**
- ▶ important dates → website

Further Questions / Application



<https://go.tum.de/396156>

