DEPARTMENT OF

MATHEMATICS AND MATHEMATICAL STATISTICS

UMEÅ UNIVERSITY

Our department in numbers

- Around 90 employees
- 20 nationalities
- 7 Professors
- 32 Associate professors
- 4 Assistant professors
- 24 PhD students
- 8 Administrative staff
- 1 Bachelor's Programme in Mathematics
- 2 Master's Programmes: Mathematics and Mathematical Statistics
- 1 Integrated Master's Programme in Industrial Engineering and Management
- 3 Doctoral Programmes: Mathematics, Mathematical Statistics, and Computational Mathematics and Statistics

A WORD FROM THE HEAD OF DEPARTMENT

Welcome to the Department of Mathematics and Mathematical Statistics at Umeå University!

Located in a vibrant coastal city 300 kilometers south of the Arctic Circle, we are a young, multicultural, and modern department that is dedicated to providing high-quality education and research opportunities to our students.

As an internationally-oriented department, we have partnership agreements with over 37 institutions around the world, and we welcome exchange students from all corners of the globe. Each year, we teach around 1600 students in a variety of programs, including engineering, master's, bachelor's programs, and teacher education. Many of our courses are taught by active researchers who are at the forefront of their fields and are connected to both industrial applications and cutting-edge research.

In addition to our basic level education, we conduct research and research training in computational sciences, mathematics, and mathematical statistics. We have an attractive and highly dynamic research environment, and we are proud to be founding partners of a interdisciplinary research lab.

In this brochure, you'll find more information about our department and the opportunities we offer. Don't hesitate to contact us if you have any further questions. We hope to see you in Umeå soon!

Konrad Abramowicz
Head of Department, Associate professor

COMPUTATIONAL MATHEMATICS

The objective of the research group in Computational mathematics at Umeå University is to conduct research on novel computational methods for the solutions of partial differential equations modeling, for instance, physical, environmental, or economical phenomena. Furthermore, our research group promotes these methods in applications arising in education, science, and engineering. Our research is cross-disciplinary and is located at the intersection between mathematics, computer science, physics, and applications.

Research topics:

- Approximation properties of neural networks,
- Embedded discretization techniques (cut finite element methods),
- Hybrid methods and coupling technologies,
- Inverse problems,
- Mathematical analysis of finite element and finite difference methods,
- Multiscale and mixed-dimensional problems.

DISCRETE MATHEMATICS

Umeå has a large and vibrant research group in discrete mathematics, with wide-ranging interests. We organize a weekly seminar and enjoy a frequent flow of visitors, students and postdocs.

Research topics:

- Combinatorial optimisation and algorithms,
- Design theory and computational enumeration of combinatorial structures,
- Discrete geometry (finite geometry, incidence geometry...),
- Extremal and probabilistic combinatorics,
- Game theory, coding theory,
- Number theoretic aspects of representation theory,
- Percolation theory, random processes and statistical mechanics,
- Rigidity theory, motions of articulated structures.

MATHEMATICAL STATISTICS

Our research in mathematical statistics aims to develop advanced methods that address real-world challenges and are applicable in a wide range of areas in science, industry and society.

Research topics:

- Biostatistics and bioinformatics,
- Compressive sensing,
- Disease mapping,
- Functional data analysis,
- Generalized additive models,
- Interpretable machine learning,
- Point process statistics,
- Signal and image analysis,
- Spatial statistics,
- Spatio-temporal statistics and statistical learning,
- Time-frequency analysis,
- Trajectory data analysis.

GEOMETRY

Our research in in geometry explores geometric structures from several complementary perspectives, ranging from discrete and combinatorial geometry to complex and differential geometry. We study how geometric ideas interact with algebra, analysis and probability, as well as their emerging applications in machine learning.

Research topics:

- Affine and tropical geometry,
- Combinatorial geometry,
- Complex and differential geometry,
- Geometry and symmetries of differential equations,
- Geometry of graphs and networks,
- Geometric deep learning,
- Incidence geometry, finite geometry and coding theory,
- Structural rigidity and kinematics.

MATHEMATICAL MODELLING AND ANALYSIS

Our work in mathematical modeling and analysis cuts across subjects and applies sophisticated mathematical and computational tools to study challenging problems.

Research topics:

- Analysis of partial differential equations,
- Decision making under risk and uncertainty,
- Dynamics on networks,
- Evolutionary biology,
- Financial risk management and hedging,
- Functional analysis and operator theory,
- Geometric analysis and pluripotential theory,
- Irreversible investment and real options,
- Kinetic theory,
- Mathematics for energy conversion processes,
- One and several complex variables,
- Operations research,
- Theoretical ecology.

MATHEMATICAL FOUNDATIONS OF ARTIFICIAL INTELLIGENCE

Our overarching goal is to uncover the mysterious successes and failures of modern machine learning systems, such as deep neural networks. We apply advanced mathematical techniques to study their fundamental properties and develop novel models and methods. Particular interests include high-dimensional optimization, symmetries in neural networks, and geometric deep learning.

Research topics:

- Compressive sensing,
- Deep learning in singular geometries,
- Distributed and federated optimization,
- Geometry of neural networks,
- Neural differential equations,
- Non-convex and non-smooth optimization,
- Quantum computer optimization.

INTEGRATED SCIENCE LAB

IceLab (Integrated Science Lab) is a leading research and educational center focused on understanding living systems through the use of scientific tools and methodologies. With a diverse group of approximately 40 members and 30 affiliated scientists from various fields, including mathematics, physics, ecology, microbiology, and computer science, the IceLab is at the forefront of advancing knowledge in this area. Address: https://www.umu.se/en/icelab/

EXTERNAL COOPERATION

At the department, we recognize the importance of collaborating with external organizations in order to strengthen both our research and teaching. The demand for statistical and mathematical expertise is high in both the private and public sectors, particularly as data, automation, artificial intelligence, and digitalization continue to grow and evolve. We believe that working with external partners can bring new perspectives, resources, and opportunities that enhance our efforts and impact.

We are proud to have collaborations with a variety of organizations, including multinational companies, municipalities, regional hospitals, and nonprofit organizations. These partnerships allow us to contribute our expertise to a wide range of projects and initiatives, and to stay connected to the needs and challenges of the larger community. We are committed to being an engaged and involved academic partner, and look forward to continuing to build strong and mutually beneficial relationships with our external partners.

DEGREE PROGRAMS

3 year Bachelor's Programme in Mathematics
(English language on advanced courses)

The bachelor's programme offers a three-years undergraduate degree in mathematics.

- A solid, generalist and modern mathematical education.
- Courses across pure mathematics, mathematical statistics and computer science.
- Possibility of an exchange semester abroad integrated in the study plan.
- A friendly and relaxed academic atmosphere, with close contacts between students and faculty.
- Ideal preparation for master's studies in mathematics, mathematical statistics, data science, artificial intelligence or computational science.

2 year Master's Programmes in Mathematics and in Mathematical Statistics
(taught in English)

Our master's programmes offer two years of advanced-level education in mathematics and mathematical statistics.

- A theoretical foundation for a career in research and development, be it in the public sector, in finance, in tech or in academia.
- Specialisations in finance engineering, computational mathematics, discrete mathematics and mathematical statistics (including application to AI, big data, and machine learning).
- An innovative mentoring scheme pairing programme student to active researchers.
- A horizontal, non-hierarchical culture with the possibility of close contacts and informal exchanges with lecturers and researchers.
- Small class sizes, excellent physical facilities and a modern study environment.
- Freedom to pick and choose courses across mathematics, statistics and computer science and to tailor your degree to your interests.

Further information

Master's Programmes in Mathematics

Master's Programmes in Mathematical Statistics

Specialisation in Financial Engineering

5 year Integrated Master's Programme in Industrial Engineering and Management
(English language on advanced courses)

The programme is focusing on the combination of technical knowledge from fields of mathematics and computing science together with economics and leadership.

- Direction of the programme is focused on mathematical modelling.
- Compulsory courses in calculus, linear algebra, differential equations, optimisation, probability theory, statistics, and programming. In parallel students obtain the obligatory training in economics and management.
- Three specialisations: Risk management, Optimisation and logistics, and Data Science.
- The great majority of final projects are made in cooperation with industry.
- About half of students spend part of their studies abroad.

COURSES OFFERED IN ENGLISH

All courses are 7.5 ECTS unless otherwise specified.
Please note that some courses are given every second year.

Bachelor's level

- Algebraic Structures
- A Mathematical Introduction to Machine Learning
- Complex Analysis
- Continuous Optimization
- Introduction to Graph Theory
- Real Analysis
- Topology

Advanced level

- Algebraic and Geometric Combinatorics
- Current Research Topics in Mathematical Statistics
- Design of Experiments and Advanced Statistical Modelling (15 ECTS)
- Discrete Modelling
- Extremal and Probabilistic Combinatorics
- Financial Mathematics
- Graph Theory
- Integer Programming
- Integration Theory
- Investment under Risk and Uncertainty
- Mathematical Modelling of Economic Systems
- Monte Carlo Methods for Financial Applications
- Multivariate Data Analysis
- Non-life Insurance Mathematics
- Numerical Methods for Partial Differential Equations
- Probability Theory
- Risk modeling in finance and insurance (15 ECTS)
- Stationary Stochastic Processes
- Statistical Inference
- Statistical Learning with High-dimensional Data
- Statistics in Genetics
- Stochastic Differential Equations
- The Finite Element Method
- Time Series Analysis

POTENTIAL COURSE PACKAGES FOR EXCHANGE STUDENTS AT MASTER LEVEL

At Umeå University it is customary that students read one or maximum two courses in parallel. Most of the courses are therefore stretching over half a term. Below we present possible course combinations for spring and autumn terms which focus on three possible student interests.

SPRING TERM		AUTUMN TERM	
MATHEMATICS			
Probabilistic and Extremal Combinatorics	Integer Programming	Continuous Optimization	Numerical Methods for PDE
Graph Theory	The Finite Element Method	Probability Theory	Stochastic Differential Equations
MATHEMATICAL STATISTICS			
Time Series Analysis	Design of Experiments and Advanced Statistical Modelling	Probability Theory	Inference Theory
Statistics in Genetics		Multivariate Data Analysis	Statistical Learning with High-dimensional Data
FINANCIAL ENGINEERING			
Time Series Analysis	Financial Mathematics	Risk modeling in finance and insurance	
Investment under Risk and Uncertainty	Monte Carlo-methods for Financial Applications	Deep Learning in Finance	Stochastic Differential Equations

DOCTORAL STUDIES

Doctoral studies at our department can be undertaken in the following subjects:

- Mathematics
- Mathematical Statistics
- Computational Mathematics and Statistics

A PhD degree consists of 240 ECTS. To qualify for the degree, you need an approved PhD thesis of at least 120 ECTS and doctoral courses. PhD students at the department are, as a rule, employees of the university under a fixed-term contract of four years of full-time study. The main task is to pursue their doctoral studies, including active participation in research and coursework. Quite often, a moderate amount of teaching can be part of the position, in which case the term can be extended to a maximum of five years.

Further information

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CONTACT DETAILS

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DEPARTMENT

Webpage

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