

DEPARTMENT OF

MATHEMATICS AND MATHEMATICAL STATISTICS



UMEÅ UNIVERSITY

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 25 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 three interdisciplinary research labs.

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!

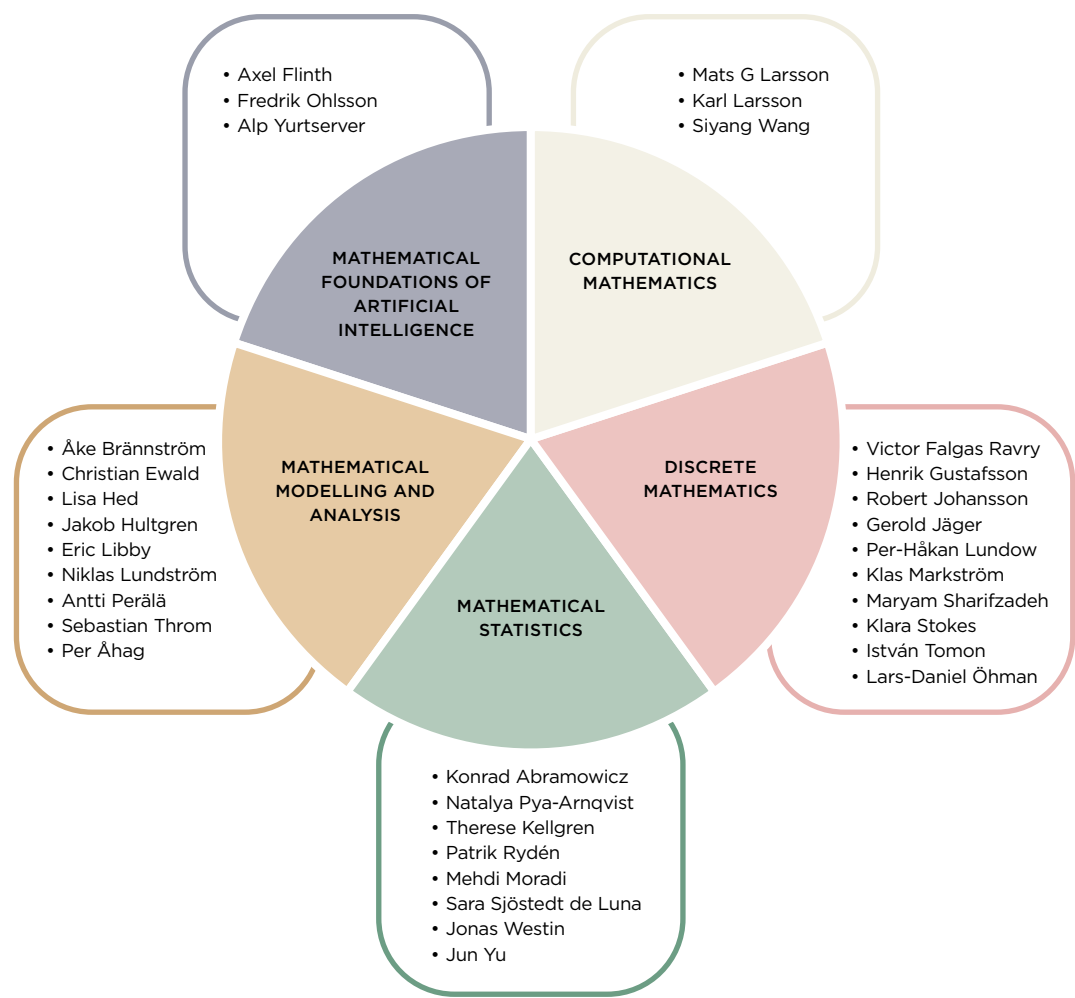


Åke Brännström
Head of Department, Professor

Our department in numbers

- Approximately 100 employees
- Professors: 7
- Associate professors: 29
- Assistant professors: 6
- PhD students: 25
- Bachelor's Programme: 1 (Mathematics)
- Master's Programmes: 2 (Mathematics, Mathematical Statistics)
- Integrated Master's Programme: 1 (Industrial Engineering and Management)
- Doctoral Programmes: 3 (Mathematics, Mathematical Statistics, Computational Science and Engineering)

RESEARCH DISCIPLINES AND TOPICS



To contact any of the researchers use e-mail address of the format:
name.surname@umu.se (without diacritics)

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.

The main research topics are:

- mathematical analysis of finite element and finite difference methods,
- embedded discretization techniques (cut finite element methods),
- hybrid methods and coupling technologies,
- multiscale and mixed-dimensional problems,
- approximation properties of neural networks.

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.

Our research topics include:

- graphs and hypergraphs,
- extremal combinatorics,
- random graphs, random processes and limit objects,
- combinatorial optimization, sensitivity analysis,
- algorithms and their analysis,
- game theory,
- combinatorial and computational group theory,
- incidence geometry, combinatorial design theory,
- geometric realizations of combinatorial structures,
- rigidity and motions of articulated structures,
- coding theory and finite geometry,
- percolation theory and statistical mechanics,
- number theory and representation theory.

MATHEMATICAL STATISTICS

Research in mathematical statistics aims at developing methods for analyzing data and is applicable in a wide range of areas in science, industry and society. The overall aim is to develop tools that allow us to extract information from data. We develop theory, stochastic models and statistical methods for analysis of complex and large data, which include spatiotemporal data, functional data, and high-dimensional data.

The main research topics include:

- biostatistics and bioinformatics,
- compressive sensing,
- functional data analysis,
- medical imaging,
- point processes,
- change point detection,
- spatial statistics,
- spatio-temporal modelling.

MATHEMATICAL MODELLING AND ANALYSIS

Mathematical modeling and analysis are cross-cutting subjects in which sophisticated mathematical and computational tools are applied to study challenging problems. The research group is composed of active researchers with diverse backgrounds in mathematical analysis and mathematical modelling.

Our research topics include:

- several complex variables, in particular pluripotential theory and geometry,
- existence, uniqueness, regularity and estimation of solutions to partial, differential equations,
- functional analysis and operator theory,
- financial mathematics,
- mathematical biology.



MATHEMATICAL FOUNDATIONS OF ARTIFICIAL INTELLIGENCE

Our group investigates mathematical foundations of artificial intelligence with the goals of uncovering the mysterious success and failures of complex machine learning models and developing theories, methods and software that expand the frontiers of AI. We particularly focus on two interrelated research topics that fall into this broad template. The first one concerns how to accommodate symmetries explicitly in machine learning models. The second one concentrates on high-dimensional and large-scale optimization problems and the deployment of algorithms in modern computing systems.

Our research topics include:

- equivariance of neural networks,
- neural differential equations,
- learning on manifolds,
- compressive sensing,
- implicit regularization and theory of deep learning,
- distributed and federated optimization,
- non-convex and non-smooth optimization,
- operator splitting and variational inference,
- optimization with quantum computers.

INTERDISCIPLINARY RESEARCH LABS



UMEÅ UNIVERSITY
UMIT RESEARCH LAB

UMIT Research Lab is a hub for groundbreaking research in computational science and engineering. Our team works closely with industry partners to develop and test innovative software tools for real-time simulation and high-performance computing. Our state-of-the-art lab facilities provide an ideal environment for conducting cutting-edge research in this field. Address: <http://www.org.umu.se/umit/english/>



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 team of approximately 20 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: <http://icelab.se>



Computational Life science Cluster (CLiC) is a bioinformatics core facility that uses advanced computational and statistical tools and approaches to gain a deeper understanding of complex biological systems. Our research focuses on the fields of genomics, proteomics, and metabolomics, and we are committed to advancing the field of bioinformatics through cutting-edge research and innovative strategies. Address: <https://www.umu.se/en/research/infrastructure/clic/>



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 mathematical finance and modelling, 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

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

Mathematics (*Bachelor's level*)

- Real Analysis (7.5 ECTS*)
- Topology (7.5 ECTS*)
- Complex Analysis (7.5 ECTS*)
- Introduction to Graph Theory (7.5 ECTS*)
- Algebraic Structures (7.5 ECTS*)
- Continuous Optimization (7.5 ECTS)
- A Mathematical Introduction to Machine Learning (7.5 ECTS*)

Mathematics (*Advanced level*)

- Transform Methods (7.5 ECTS)
- Probabilistic and Extremal Combinatorics (7.5 ECTS*)
- Algebraic and Geometric Combinatorics (7.5 ECTS*)
- Stochastic Differential Equations (7.5 ECTS)
- The Finite Element Method (7.5 ECTS)
- Mathematical Modelling of Economic Systems (7.5 ECTS)
- Financial Mathematics (7.5 ECTS)
- Monte Carlo Methods for Financial Applications (7.5 ECTS)
- Enterprise Risk Management (15 ECTS)
- Integration Theory (7.5 ECTS*)
- Discrete Modelling (7.5 ECTS)
- Integer Programming (7.5 ECTS)
- Graph Theory (7.5 ECTS*)
- Numerical Methods for Partial Differential Equations (7.5 ECTS)

Mathematical Statistics (*Advanced level*)

- Design of Experiments and Advanced Statistical Modelling (15 ECTS)
- Statistical Learning with High-dimensional Data (7.5 ECTS)
- Computer Intensive Methods in Statistics (7.5 ECTS)
- Multivariate Data Analysis (7.5 ECTS)
- Probability Theory (7.5 ECTS)
- Inference Theory (7.5 ECTS*)
- Statistics in Genetics (7.5 ECTS)
- Stationary Stochastic Processes (7.5 ECTS*)
- Time Series Analysis and Spatial Statistics (7.5 ECTS)
- Topics in Statistics (7.5 ECTS*)

In addition to the regularly recurring courses listed above, we offer in most academic years additional English-language advanced-level courses on topics that change from year to year.

(*) indicates that the course is given every second year.

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	
DISCRETE/COMPUTATIONAL MATHEMATICS			
Probabilistic and Extremal Combinatorics	Integer Programming	Continuous Optimization	Numerical Methods for PDE
Graph Theory	Finite Element Methods	Probability Theory	Stochastic Differential Equations
MATHEMATICAL STATISTICS			
Time Series Analysis and Spatial Statistics	Design of Experiments and Advanced Statistical Modelling	Probability Theory	Inference Theory
Statistics in Genetics		Multivariate Data Analysis	Statistical Learning with High-dimensional Data
FINANCIAL MATHEMATICS			
Time Series Analysis and Spatial Statistics	Financial Mathematics	Enterprise Risk Management	
Introduction to Database Management	Monte Carlo-methods for Financial Applications	Continuous Optimization	Stochastic Differential Equations



DOCTORAL STUDIES

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

- Mathematics
- Mathematical Statistics
- Computational Science and Engineering (specialization in Mathematics or Mathematical 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





CONTACT DETAILS

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Head of Bachelor programme: Berit Bengtson

Head of Master s programmes: Victor Falgas Ravry

International Contact Person: Konrad Abramowicz

DEPARTMENT



Webpage



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