

GRADUATE STUDIES MATHEMATICS

Polytechnique Montréal's graduate programs in mathematics generate highly qualified personnel able to work with engineers to solve pressing scientific issues, in addition to advancing knowledge in areas like operations research, probability and statistics, and scientific computing. Graduate studies in mathematics are aimed at mathematicians and computer scientists who enjoy the practical applications of mathematics, as well as engineers wishing to acquire advanced knowledge for their professional practice.

The Department of Mathematics and Industrial Engineering offers a range of courses that focus on modelling industrial problems and solving them with the most effective mathematical means. Because the professors are active researchers, the curriculum is regularly updated to reflect new industry trends and needs. Students in the research stream often work on real industry problems, and may have the opportunity to meet with industry partners. Professors in the department, recognized internationally for their expertise, have forged many links with researchers from other universities around the globe.

MULTIDISCIPLINARY RESEARCH

Research in the department falls into three priority areas that occasionally overlap. Each area entails wideranging expert knowledge, enabling multidisciplinary research that might involve mathematicians, engineers and/or researchers in other fields. Our priority research areas are:

Probability and statistics

Studies on the effects of wear
Water supply forecasting
Data exploration
Character recognition
Stochastique optimization of reservoirs
Time series modelling

Operations research

Transport operations planning
Staff schedule planning
Income management
Natural resource development
Optimized design in engineering
Supply chain management

Scientific computing and digital analysis

Polymer injection moulding
Bifluid flow
Interface physics
Magnetohydrodynamics
Superconductor heat transfer

Mathematics research targets many different areas, such as those listed in the pie chart above.

Operations research : Optimization, mathematics programming, graphs and networks, modelling and simulation, global optimization;

Probability and statistics : Data analysis, stochastic processes, spatial classification and statistics, machine learning;

Scientific computing and digital analysis : Finite element and finite volume methods, estimated errors, multi-scale models, adaptiveness and parallelism.

RESEARCH PARTNERS

Research in mathematics is relevant for many organizations. Whether it consists of modelling fluid behaviour, designing decision-making support tools or optimizing network planning, such work often hinges on input from various partners, such as Air Canada, Boeing, Bombardier, ExPretio, General Fusion, Giro, Hatch, Hydro-Québec, Kronos, Loto-Québec, Ministère de la Défense nationale, Ministère de l'Éducation et de l'Enseignement supérieur, Ministère des Transports, de la Mobilité durable et de l'Électrification des transports, Société de transport de Montréal, Société nationale des chemins de fer français, Ville de Montréal, etc.

JOB PROSPECTS

While a number of recent graduates are now employed as professors or researchers at universities in Québec, North America and even overseas, the majority have found interesting jobs with organizations like Hydro-Québec, Marconi, Teclut, Pratt & Whitney, Nortel, Kronos, Giro, ExPretio, Hôpital du Sacré-Coeur, Montréal General Hospital, National Bank of Canada, Banque Nationale de Paris, Électricité de France, Air Canada, Air France, Northwest Airlines, Acquisio, Standard Life, CAE, and Bell Mobility.

RESEARCH UNITS AND INFRASTRUCTURES AT THE SERVICE OF KNOWLEDGE

The Department of Mathematics and Industrial Engineering has four research chairs in mathematics and is associated with three Université de Montréal mathematics research centres. True centres of excellence equipped with state-of-the-art facilities, these units are thriving hubs of scientific interaction whose work supports our research priorities.

NSERC - Hydro - Quebec - Schneider Electric Industrial Research Chair on Optimization for the Smart Grid

This Chair aims to improve the performance and reliability of large-scale power grids through the application of new mathematical optimization techniques. Integrating new sources of electricity, the changing demand for electricity, growing environmental concerns as well as evolving telecommunication technologies lead to the development of “smart” grids. These grids offer greater flexibility to adjust electricity flows between producers and consumers and appear to be the ideal solution for increased energy efficiency.

GERAD, CIRRELT, CREPEC

A number of department researchers are active in the *Groupe d'études et de recherche en analyse des décisions* (Group for Research in Decision Analysis – GERAD), the *Centre interuniversitaire de recherche sur les réseaux d'entreprise, la logistique et le transport* (Interuniversity Research Centre on Enterprise Networks, Logistics and Transport – CIRRELT), and the *Institut de Valorisation des données* (Institute for Data Valorization – IVADO), groups whose interests include applying optimization models to fields like transportation, logistics, engineering, telecommunications, finance, business intelligence and cybersecurity. Together, these groups employ the largest number of operations researchers in the world. Other department researchers are part of the *Centre de recherche en plasturgie et composites* (Centre for Applied Research on Polymers – CREPEC), which focuses on the development of new materials.

Canada Excellence Research Chair in Data Science for Real-time Decision making

The Canada Excellence Research Chair in Data Science for Real-Time Decision-Making aims at developing new tools and methodologies that will allow massive volumes of data from multiple sources to be processed and analyzed in real time to obtain usable knowledge and to automate decision making. By combining processes for analyzing highly targeted data and real-time decision making, the mathematical model-based tools will help organizations improve performance, by creating highly customized outputs and considering the environments, needs and individual behaviors of the clients or users.

The applications that result will foster new business models that are based on accurate depictions of user behaviors and expectations, combined with competitors' responses. The many sectors that could benefit include transportation management, energy, health care and manufacturing, as well as supply chain management and logistics. This new paradigm will be possible by the close integration of Machine Learning (to acquire the knowledge) and Mathematical Optimization (to help taking optimal decisions based on that knowledge).

RESEARCH BUDGET

Around \$2 million per year are obtained by professors in grants and industrial contracts.

INFORMATION

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