



APPLIED

AI

concordia.ca/ginacody/research/ai

INSTITUTE

CONCORDIA

APPLIED ARTIFICIAL INTELLIGENCE AT CONCORDIA

Concordia University is located in the heart of Montreal, a city that serves as a global hub for artificial-intelligence (AI) research and development (R&D).

According to recent studies, Montreal has seen nearly \$500 million invested to create AI research institutes and to drive AI implementation, and more than \$3 billion has been invested in AI R&D in the city since 2016.

With more than 400 researchers focused on this emerging field and approximately 11,000 students enrolled in AI-related courses across the city's five universities, Montreal is at the epicentre of Canada's AI research.

Concordia is well-known for its world-class AI researchers — particularly in the area of applied AI — with a strong record of collaboration with industry and government.

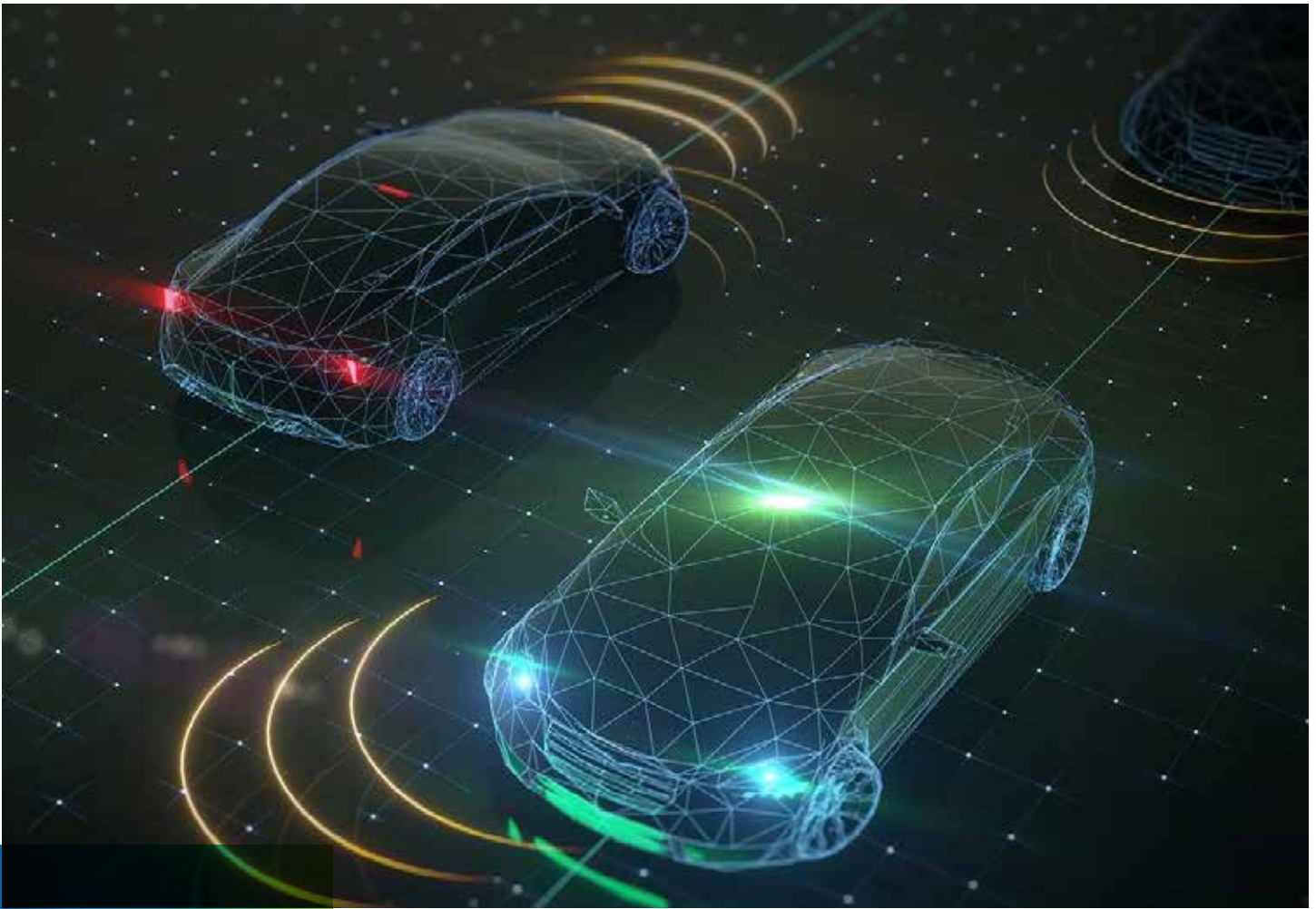
Our researchers have partnered with start-ups, small and medium-sized companies and large corporations to address important challenges in the fields of telecommunications, cybersecurity, buildings, smart cities, critical infrastructure, transportation, manufacturing, gaming, medical diagnostics, pattern recognition and finance.

A recent example is our collaboration with Ericsson for its Global Artificial Intelligence Accelerator, which has already attracted \$1.2 million in funding to support 25 Concordia graduate students and postdoctoral researchers.

“Our emphasis is on solving real-life problems, even when they cross the traditional boundaries of AI fields, as we are interested in real solutions for real-world problems. Concordia's Applied AI Institute translates AI research and applies it to the physical world across a broad range of key sectors.”

— KASH KHORASANI, FOUNDING DIRECTOR, APPLIED AI INSTITUTE





WHAT IS ARTIFICIAL INTELLIGENCE?

Artificial intelligence can be defined as any machine that exhibits human-like cognitive functions such as learning, reasoning, forecasting, recognizing, planning and problem-solving.

Unlike traditional machines that are only capable of mechanical or preprogrammed functions, AI machines are designed to make decisions using real-time data. By using external sensors, digital data or other forms of data input, these machines are able to rapidly analyze incoming information and make informed decisions based on the results of their analysis.

While popular culture often depicts AI in the form of humanoid robots, most AI systems today are indistinguishable from traditional computer programs to the casual observer.

Some prominent examples of current AI applications include Apple's Siri and Amazon's Alexa voice-recognition systems; Google Translate and Grammarly text editing; autonomous cars and drones; and the personalized recommendations on platforms such as Netflix and Spotify.

WHY IS APPLIED AI IMPORTANT?

Starting in the last decade, artificial-intelligence technology has seen massive growth. Today, there is virtually no area of industry or society that hasn't been impacted by AI. This powerful technology is revolutionizing the way we live, work, play, communicate and travel — and this is only the beginning.

AI has the potential to help us tackle some of the most pressing challenges facing our world. From climate change, health and well-being, traffic congestion and sustainable cities to food production and wildlife preservation, AI can help us develop solutions to these urgent challenges faster and more effectively than we ever imagined.

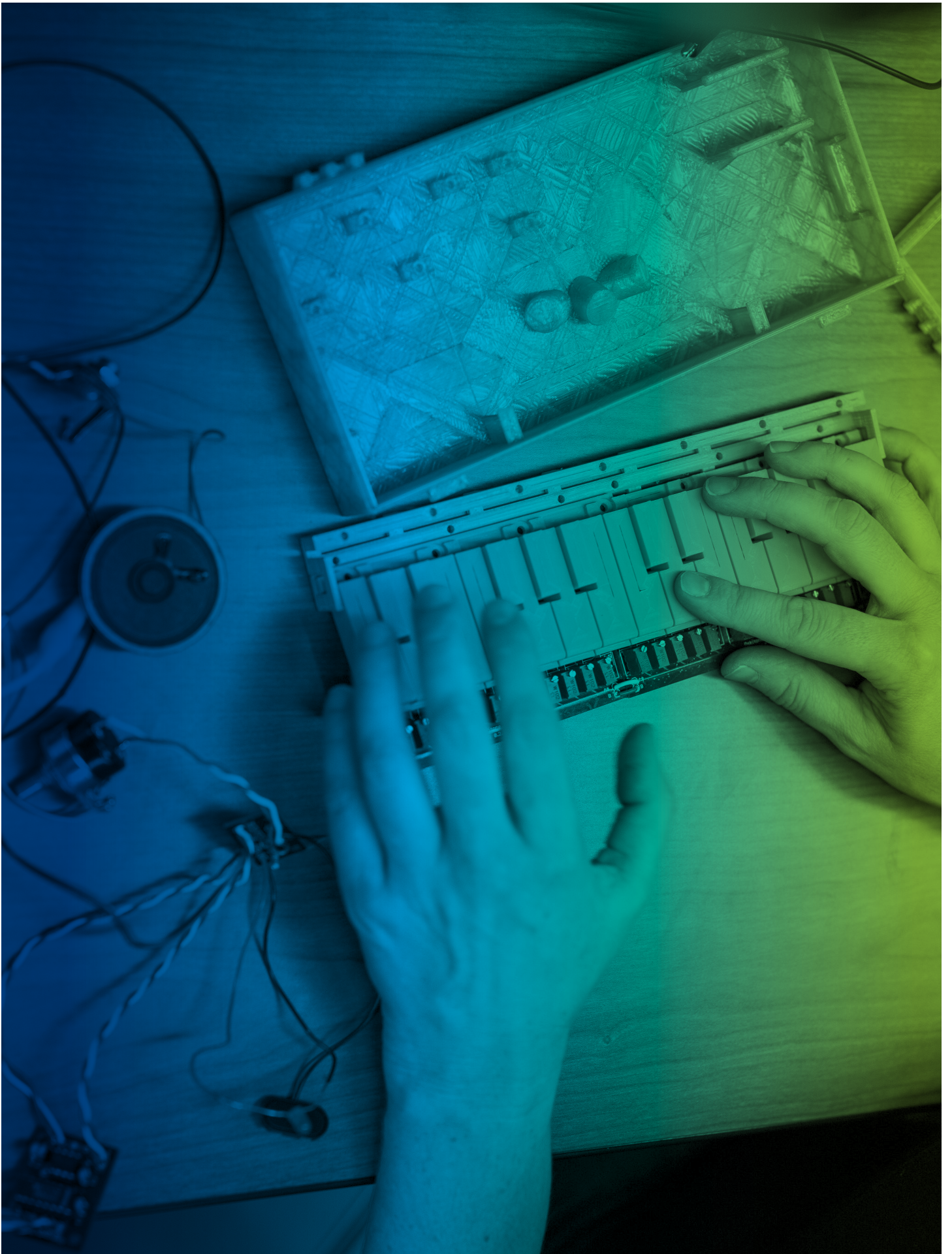
Moreover, the global AI market is expected to grow from roughly \$10 billion in 2018 to \$126 billion by 2025 and contribute up to \$15.7 trillion per year to the global economy by 2030. In fact, according to Eric Schmidt, former CEO of Google and chair of the recent U.S. National Security Commission on AI, the economic impacts of AI could be more than \$50 trillion in the next 20 years.

Some studies estimate that 70 per cent of companies will have adopted AI technologies by the end of the decade.

In fact, some studies suggest that companies that integrate AI technology could see their cash flow double by 2030, while those that don't could see their revenue streams drop by 20 per cent in the same time frame.

That said, AI technology is not without its weaknesses and liabilities. The use of AI raises several important ethical, security and privacy issues, and there have been numerous reports of ingrained biases in various AI systems, such as voice- and face-recognition software and chatbots.

These ethical and systemic concerns need careful attention and investigation by independent and impartial researchers and academic institutions. As a trusted anchor institution in Montreal, Concordia has great capacity to fill this role between academia, industry and government.



NEXT-GENERATION APPLIED AI INSTITUTE

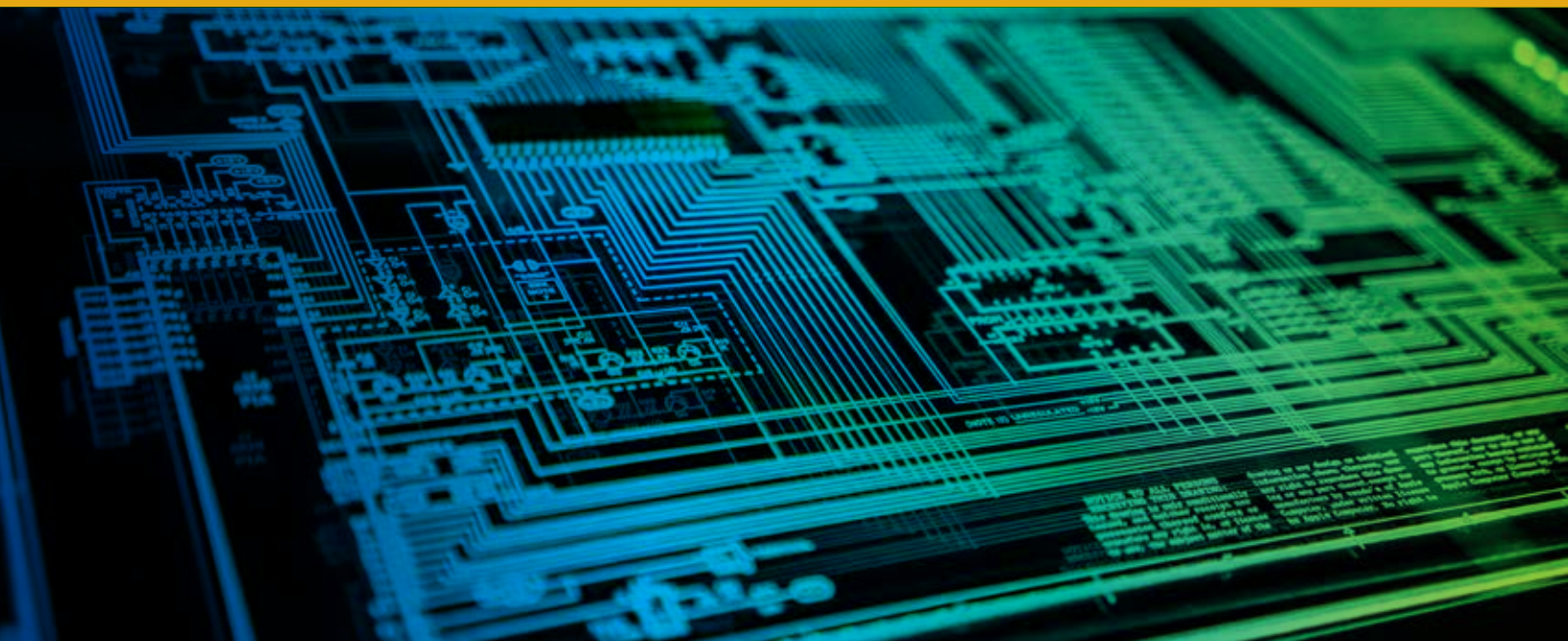
Concordia's Applied AI Institute establishes the university as one of the leading centres for AI research in the country. The institute gathers Concordia's world-renowned researchers and high-impact research centres from across the university's four faculties under one truly multi- and cross-disciplinary umbrella.

Harnessing the full capacity of the university's resources, networks and cutting-edge facilities, the institute is focusing its attention on the following priorities:

- **Define and implement high-impact projects** grounded in societal and economic needs;
- **Support nascent research-driven ideas** from the ground up;
- **Develop innovative technologies** for all AI-related research areas at the university;
- **Develop ethical and secure frameworks** for the ideas and technology in development;
- **Train the next generation of talent** to succeed and thrive in the rapidly evolving field of artificial intelligence.

“Industrial and human activities generate a huge amount of data every day. These data hold the potential to allow efficient response and decision-making via AI techniques. One of the objectives of the Applied AI Institute is the accurate collection, reporting, sharing and use of generated data, keeping in mind ethical and privacy considerations and FAIR (Findable, Accessible, Interoperable and Reusable) principles.”

— NIZAR BOUGUILA, FOUNDING DIRECTOR, APPLIED AI INSTITUTE



RESEARCH CLUSTERS

The Applied AI Institute groups all participating researchers and research centres into three overarching clusters overseen by the institute's steering committee. Each research cluster focuses on different themes, yet many of our researchers and centres are active across more than one cluster. Here are the institute's three clusters:

- **AI & Society:** This cluster aims at developing core AI applications while questioning their nature and impact on societies. Scientists developing core AI technologies do so in open dialogue with researchers from the social sciences and the arts. Together, they explore the best applications and uses for these new technologies for the benefit of societies. Core technologies include data mining, machine learning, pattern recognition, computer vision and graphics, cybersecurity, software engineering and computing systems.
- **AI & Science:** Deep-learning methods for medical imaging have evolved to the point where these AI systems outperform expert clinicians in several areas. However, the current deep-learning models are data-hungry and require large, high-quality databases to be effective. This research cluster will seek to develop data-efficient algorithms to transcend this challenge. This will enable our researchers to design, develop and implement highly accurate and trustworthy AI-based autonomous medical diagnosis/prognosis systems.
- **AI & Emerging Technology:** This cluster will integrate research topics related to smart cities, industry and manufacturing, and aerospace. For smart cities, researchers will work with the private and public sector to develop AI methods to harness the vast quantity of data produced by emerging technologies and sources to better operate and plan urban infrastructure.

Researchers will also explore promising ideas around design, development and application of industrial AI. Our goal is to develop technologies that can advance robust, real-time and adaptive smart production-monitoring, maintenance-management and quality-control systems.

A third critical topic of research for this cluster is aerospace, with a focus on aviation management, mobility and autonomy, and designing and optimizing aircraft systems and propulsion. The rapidly growing number of autonomous unmanned vehicles, combined with the promise of future urban air taxis and drones — plus increasing demands for sustainable and environmentally friendly solutions — presents a significant challenge and makes this a topic of high importance for our institute.

“Applied means interdisciplinary.”

— TRISTAN GLATARD, FOUNDING DIRECTOR, APPLIED AI INSTITUTE



RESEARCH CENTRES

The Applied AI Institute collaborates with eight Concordia research centres from a broad section of disciplines and fields of research. While these are the institute's primary partners at Concordia, our researchers and projects extend far beyond these centres.

- **PERFORM:** Unique facility dedicated to improving health through prevention. The centre combines research, education and community engagement in the areas of physical activity, rehabilitation, nutrition and lifestyle change.
- **Milieux Institute for Arts, Culture and Technology:** Research unit working at the intersection of design, art, culture and technology. A platform for progressive imagining, critical studies, creative experimenting and interdisciplinary training where thinking and making come together to transform our encounter with technology.
- **Centre for Pattern Recognition and Machine Intelligence:** Advances research in pattern-recognition and machine-intelligence technologies and strengthens the relationships between Concordia and industry.
- **Centre for Research in Molecular Modeling:** Multi-institutional research centre that explores the molecular sciences, fostering collaborations between researchers in all fields of molecular simulations, including chemistry, biology, physics and engineering.
- **Concordia Centre for Composites:** Researches polymer composites, nanocomposites, polymer/metallic alloys, design of composite structures, testing of materials structures and properties and development of new materials and manufacturing techniques.



- **Concordia Security Research Centre (CSRC):** Brings together active and dynamic academic researchers, security practitioners, government and law-enforcement agencies, financial institutions and National Defence to foster collaboration on systems security, privacy and cyberforensics, and development activities.
- **Thermal Spray and Surface Engineering Research Centre:** Develops new solutions for industry's high demand for advanced coatings with improved resistance to environmental degrading factors such as high temperature, wear, corrosion and erosion, often under severe service conditions.
- **Hexagram:** International network dedicated to research-creation in the fields of media arts, design, technology and digital culture. The network includes researchers from sociology, art history, anthropology, game studies, philosophy and communication/media studies, in addition to artists and designers.



HIGH-IMPACT RESEARCH



Researchers are developing deep-learning methods for detecting mental health issues on social media that are not only efficient, but can also provide specific evidence to support the results. This research is led by Professor **Leila Kosseim**, researcher at the Computational Linguistics at Concordia (CLaC) Laboratory and president of the Canadian AI Association.

Professor **Wahab Hamou-Lhadj** is working with a team from Ericsson's Global AI Accelerator to use AI to streamline the process of handling system crashes at Ericsson. The overall goal is to improve the quality of telecom systems, such as those used to support internet traffic, while reducing the cost of operations.



Led by Professor **Marta Kersten-Oertel**, Concordia University Research Chair in Applied Perception, a team of researchers is working on federated learning — a machine-learning approach used to train AI models across multiple locations. Focusing on projects using federated learning in medical environments, the Applied Perception lab team is evaluating methods for segmenting brain tumours and developing an AI diagnosis system to improve treatment for patients who suffer strokes.

Concordia medical imaging researchers Professor **Yiming Xiao** and Professor **Hassan Rivaz** teamed up with spinal disorder experts from Western University to develop the first AI-based diagnostic and prognostic system for lower back pain. This system can automatically identify and track back-muscle degeneration using medical scans and has the potential to greatly improve our understanding and clinical care of low back pain — the most common musculoskeletal disorder in adults.





Professor **Chris Skonieczny**, Tier 2 Canada Research Chair in Aerospace Robotics, has been collaborating with Mission Control Space Services Inc. since 2015 to equip planetary rovers with AI for terrain classification, hazard awareness and novelty detection. This will enable rover missions to conduct more science at lower risk and contribute to maintaining Canada's global leadership in space robotics.



Professor **Suong Van Hoa**, from the Gina Cody School's Department of Mechanical, Industrial and Aerospace Engineering, is developing a cost-effective method for monitoring the occurrence of defects in structures made of composite materials for aircraft. The project uses AI to monitor defects in composite structures subjected to loading. The project goal is to reduce the number of probe points required for health monitoring, leading to lighter and more economical structures.



The Canadian Institutes of Health Research is funding a project to develop genomic classifiers of benefit from radiotherapy for women with ductal in situ carcinoma (DCIS) of the breast. DCIS is a very common disease, affecting one in six women globally. Co-led by Professor **Michael Hallett**, Tier I Canada Research Chair in Algorithmic Bioinformatics, this international team is using deep-learning approaches to interpolate missing values and combine molecular profiles with molecular imaging data.

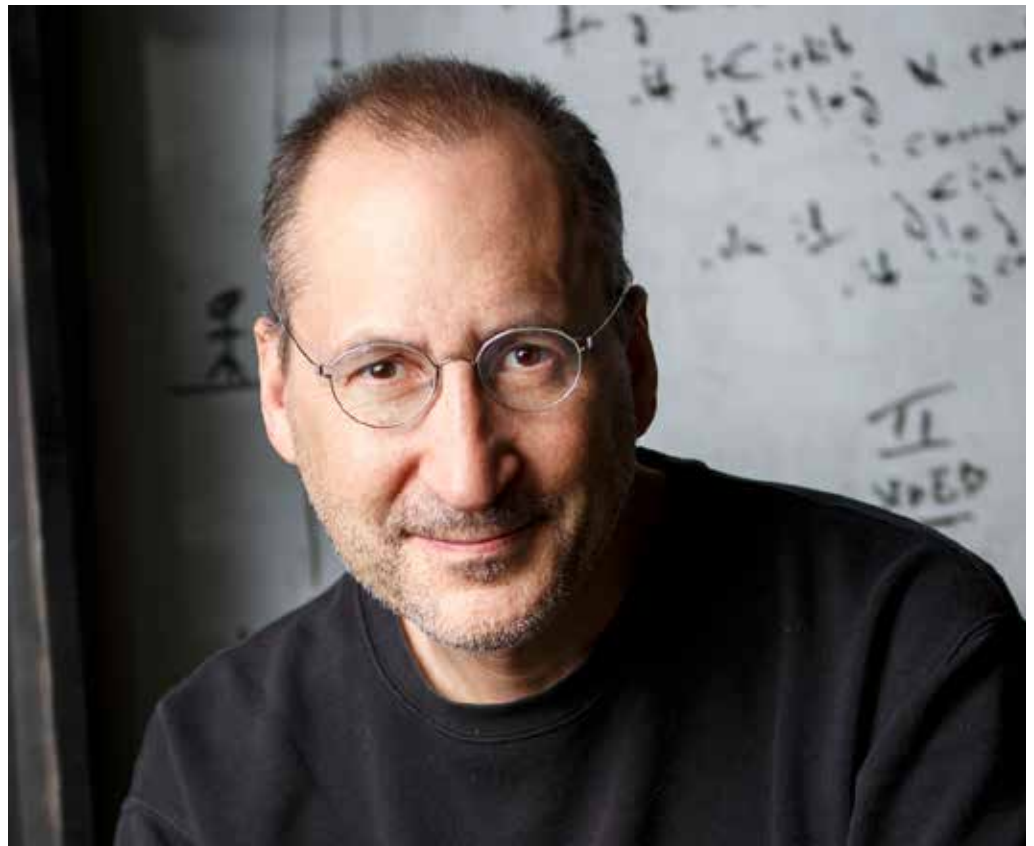
In partnership with Siemens Canada and École de technologie supérieure (ÉTS), Concordia researchers are developing methods and tools for smart supply-chain planning using Industry 4.0 technologies. Led by Professor **Nadia Bhuiyan**, vice-provost of Partnerships and Experiential Learning, this project focuses on adapting novel concepts to help companies successfully transition to Industry 4.0.





Professor **Wei-Ping Zhu**, PhD program director in the Department of Electrical and Computer Engineering, is investigating new speech-enhancement methods based on deep neural networks (DNN) for automatic speech recognition (ASR) applications. The short-term goal is to develop an integrated speech-enhancement system based on DNN that is suitable for keyword spotting and large-vocabulary ASR in the context of human-machine interface.

Faced with dwindling drug leads and growing fatalities from multidrug-resistant bacteria, the world is on the brink of the post-antibiotic era. The Mansbach Research Lab, headed by Professor **Rachael (Ré) Mansbach**, is working on increasing our understanding of antibiotic resistance and designing urgently needed novel therapeutics. This team is using a fragment-based approach for novel antibiotic hybrid design using generative deep learning.



Researcher-creator **Christopher Salter**, co-director of Hexagram, is working with artists, anthropologists and complex-systems scientists to apply machine learning to sequencing and generating light and sound compositions to create compelling artistic experiences for public spaces.



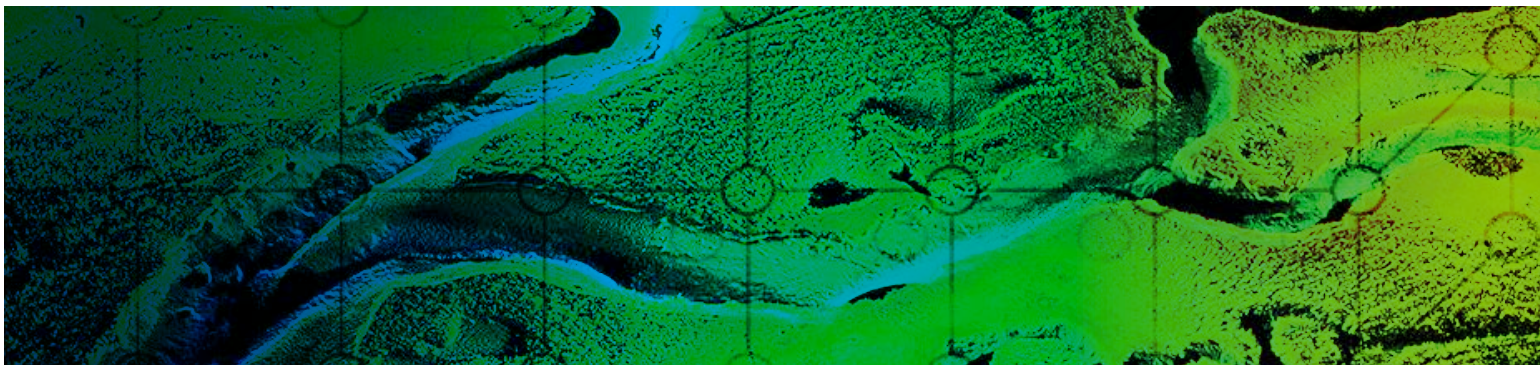
Professors **Cody Hyndman** and **Frédéric Godin**, from the Department of Mathematics and Statistics, are conducting research on machine-learning methods and innovative algorithms related to the pricing and prediction of financial instruments and the optimization of financial decision-making for risk-management purposes.



Student **Rim Dabbous**, in collaboration with linguistics professor **Charles Reiss** and the Centre for Cognitive Science and Linguistics in the Faculty of Arts and Science, is researching computationally explicit models of phonology — the abstract sound patterns in human language. In her master's research, Dabbous aims to improve on existing AI models based on neural networks and statistical learning by studying natural language structure and its acquisition.



Professor **Emad Shihab**, associate dean of Research and Graduate Studies and Concordia University Research Chair in Software Analytics, is leading the NSERC-funded SE4AI CREATE — a training program on the development, deployment and servicing of artificial intelligence-based software systems. The program aims to fill a major shortage in highly qualified professionals who can create and maintain AI-based software systems. It also teaches the ethical, legal and social aspects of AI, as well as equity, diversity and inclusion.



Biology professor **Pedro Peres-Neto**, Canada Research Chair (Tier 1) in Spatial Ecology and Biodiversity, and his research group are conducting studies at the intersection of biodiversity science and ecoinformatics. Together, they are testing and applying quantitative frameworks to better understand the processes underlying spatial patterns of biological diversity. This knowledge is critical to help mitigate accelerated biodiversity loss and ecosystem degradation.



Professor **Ann-Louise Davidson**, an education researcher and director of the new Concordia University Innovation Lab, is developing new ways to leverage AI for education and training. This includes preparing students for the future of work where they will split their efforts with AI, and on upskilling and reskilling the current workforce and offering services using conversational agents and learning analytics.



Professor **Denis Liakin** from the Département d'études françaises and Professor **Walcir Cardoso** from the Department of Education are investigating the use of mobile text-to-speech synthesizers and automatic speech recognition as tools to promote the development of pronunciation skills for learning French.



WOMEN IN AI

The Applied AI Institute prides itself on being founded on the principles of equity, diversity and inclusion. Currently, women are highly underrepresented in engineering and computer science — two foundational fields in the area of artificial intelligence.

Having our origins in the Gina Cody School of Engineering and Computer Science — the first engineering and computer science faculty in North America named after a woman — our vision is to achieve equity, diversity and inclusion in the physical and digital spaces we occupy to nurture and enhance our collective growth.

Our goal is to be the destination of choice for women in the field of artificial intelligence.



“A future world with AI must embrace diversity in order to reflect the society in which we live. The Applied AI Institute will offer a platform for women leaders and role models in AI to shape technological advances, create an inclusive AI community and inspire, educate and support the next generation of female leaders in AI.”

— **NADIA BHUIYAN, VICE-PROVOST, PARTNERSHIPS AND EXPERIENTIAL LEARNING,
PROFESSOR, MECHANICAL, INDUSTRIAL AND AEROSPACE ENGINEERING**



SERVICES

- **AI education:** We offer undergraduate education around the theme of artificial intelligence, as well as several specialized graduate-level courses and a range of AI-related graduate degrees.
- **Training and workshops:** The institute offers training courses and workshops for start-ups, as well as established companies, and we promote AI use in society through our general workshop series.
- **Centre of Excellence:** The Applied AI Institute is home to talent and start-ups as well as labs, industry representatives and investors to attract talents and boost the commercialization of AI with a close collaboration between stakeholders.
- **Office of Industry Collaboration:** This office helps coordinate and communicate effectively with industry to offer relevant workshops, establish joint research projects and supply experts to meet the industry's needs and demands.
- **Office of Start-ups and Consultation:** This office provides various forms of consultation to entrepreneurs and teams seeking to launch start-ups in the area of artificial intelligence. It helps link prospective start-ups with investors and industry stakeholders and also oversees a start-up fund used to create committees to study and evaluate start-up ideas and offer seed funding to projects with promising ideas.

LEADERSHIP TEAM



KASH KHORASANI
FOUNDING DIRECTOR
Professor and Tier 1 Concordia
Research Chair, Electrical and
Computer Engineering
khashayar.khorasani@concordia.ca



NIZAR BOUGUILA
FOUNDING DIRECTOR
Professor at the Concordia Institute
for Information Systems Engineering
nizar.bouguila@concordia.ca



TRISTAN GLATARD
CO-DIRECTOR
Associate professor and Canada
Research Chair (Tier 2) on
Big Data Infrastructures for
Neuroinformatics
tristan.glatard@concordia.ca



FENWICK MCKELVEY
CO-DIRECTOR
Associate Professor,
Communication Studies
fenwick.mckelvey@concordia.ca



AN INSTITUTE LIKE NO OTHER

The strength of the Applied AI Institute lies in our truly multidisciplinary approach to advancing AI research, education and technology to help tackle some of the most pressing challenges facing society.

Our mission is simple — to serve as the driving force for applied AI integration across industry and society. Located in the heart of Montreal, one of the world's thriving centres for AI research and development, our institute is uniquely positioned at the intersection of academia, industry, education and government.

Our institute brings together outstanding scientists, students, scholars and professionals and empowers them to focus on larger-scale and long-term research around both fundamental and applied artificial-intelligence projects.

As a trusted anchor institution in Montreal, Concordia is well-positioned to support and enhance our capacity to collaborate with communities, industry partners and government.

By leveraging the significant resources, knowledge and expertise at the institute, we are developing ethical and secure AI technologies and innovations to create stronger, resilient, equal and diverse societies. Our goal is to harness the full capacity of the Applied AI Institute to make a lasting and meaningful impact in Canada and around the world.

“Our main objectives are to leverage Concordia’s critical mass of expertise to promote our applied AI capacity and enhance and expand our collaborations with other AI initiatives and resources within Montreal’s AI ecosystem. By applying a multi- and cross-disciplinary focus and vision, we are able to produce highly qualified personnel with hands-on training who can be easily absorbed into the AI industry and academia.”

— KASH KHORASANI, FOUNDING DIRECTOR, APPLIED AI INSTITUTE

APPLIED

AI

concordia.ca/ginacody/research/ai

INSTITUTE



Get in touch with the Next-Generation AI Applied Institute:

- concordia.ca/ginacody/research/ai
- applied.ai@concordia.ca

Learn how you can support the next generation of Concordia students.
Contact our development staff at 514-848-2424, ext. 4856.

Share your **#CUpride** and **#CUalumni** stories via **@ConcordiaAlumni**.



concordia.ca/campaign

1455 De Maisonneuve Blvd. W., Montreal, Quebec H3G 1M8

© Concordia University, 2022.
Writer: Joseph Leger Graphic design: Trevor Browne

T22-72854

CONCORDIA