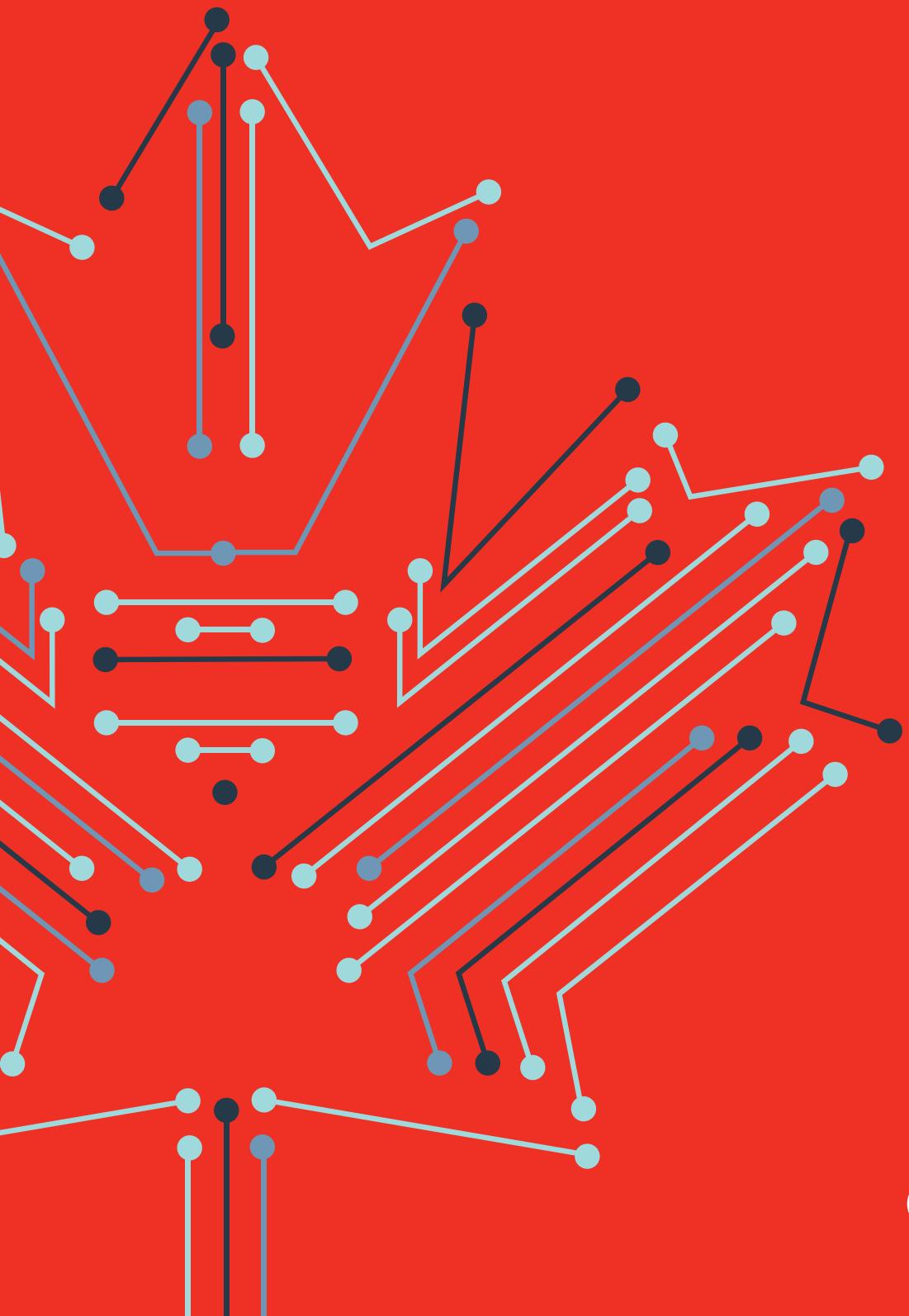


AICan 2020

CIFAR Pan-Canadian AI Strategy
Impact Report



CIFAR

CIFAR is a Canadian-based global research organization that convenes extraordinary minds to address the most important questions facing science and humanity.

By supporting long-term interdisciplinary collaboration, CIFAR provides researchers with an unparalleled environment of trust, transparency and knowledge sharing. Our time-tested model inspires new directions of inquiry, accelerates discovery and yields breakthroughs across borders and academic disciplines. Through knowledge mobilization, we are catalysts for change in industry, government and society. CIFAR's community of fellows includes 20 Nobel laureates and more than 400 researchers from 20 countries. In 2017, the Government of Canada appointed CIFAR to develop and lead the Pan-Canadian Artificial Intelligence Strategy, the world's first national AI strategy.

CIFAR is generously supported by the governments of Canada, British Columbia, Alberta, Ontario and Quebec, Canadian and international partners, as well as individuals, foundations and corporations.



EQUITY, DIVERSITY & INCLUSION

CIFAR's success is built on the combination of diverse perspectives. We acknowledge that there is more we can do to ensure that underrepresented groups, who experience systemic barriers in science, research organizations, and academia, are included in our organization and in our programs and initiatives.

In April 2020, CIFAR's first ever Action Plan on Equity, Diversity, and Inclusion (EDI) was unanimously approved by our Board of Directors. In it, we articulate our commitment to practices that promote Equity, Diversity, and Inclusion.

We commit to:

- Championing EDI efforts throughout the organization, especially at the Board and senior leadership levels
- Creating ongoing opportunities for training and education in EDI topics
- Developing frameworks for recruitment at CIFAR informed by EDI principles
- Reporting on EDI efforts internally and externally
- Embedding EDI into our fellowship, application, and program review processes
- Supporting EDI within the broader research community



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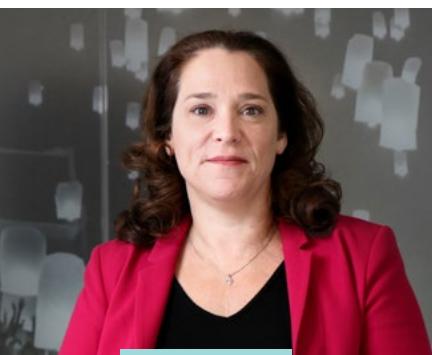
CIFAR is located in the MaRS West Tower at 661 University Avenue in Toronto.

For thousands of years, this area has been the traditional territory of many nations including the Huron-Wendat, the Seneca, the Petun, and most recently, the Mississaugas of the Credit. Today, this meeting place is still home to many Indigenous people from across Turtle Island and we are grateful to have the opportunity to work, learn and share on this land.

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MESSAGE FROM THE EXECUTIVE DIRECTOR OF THE PAN-CANADIAN AI STRATEGY



Dr. Elissa Strome
Executive Director,
Pan-Canadian
AI Strategy

In just three short years, the impact of the Pan-Canadian AI Strategy has been significant. Canada has established three new AI Institutes: Amii in Edmonton, Mila in Montreal, and the Vector Institute in Toronto, all of which have grown into dynamic hubs of their respective AI research and innovation ecosystems. Through the Pan-Canadian AI Strategy, we have named 80 Canada CIFAR AI Chairs, thus retaining or recruiting to Canada some of the world's leading AI scientists and ethicists. Working with partner universities and organizations across the country, we have advanced AI training programs for young people in Canada to give them the skills and expertise they need to understand the technology and how it can be applied to deliver positive social benefits. We have also helped to advance AI policy expertise in Canada and, with partners in the U.K. and France, we have advanced research in the societal implications of AI through CIFAR's AI & Society Program.

These are inspiring times to be part of the Canadian AI ecosystem. Those of us who have the privilege to work in this space know how passionate Canadian researchers and trainees are about developing machine learning technologies that can help make the world a better place. In the midst of the COVID-19 pandemic, Canadian AI researchers focused their efforts on some of the toughest questions raised by the SARS-CoV-2 virus. Can we predict how severely someone will be affected by the virus, based on their chest X-ray? Are there existing drugs that have already been proven safe that could be used against the novel coronavirus? How can we identify those at the greatest risk of suffering negative mental health outcomes due to social isolation?

As we look towards the future, it's harder than ever to predict what the world will look like in six months, let alone a year or two from now. We can, however, be certain that AI will continue to play an important role in helping us understand the world around us, to assist us by finding patterns in reams of data, and to take on tasks that are too repetitive or dangerous for humans to undertake. Canada is one of the great AI nations, known for our pioneering excellence in the fundamental science of deep learning and reinforcement learning, and the continued advancement of the field. We are also known for our strong shared values of deploying AI in a way that brings positive benefits to society. In these turbulent times, with so much geopolitical, economic and climatic instability, the world needs more Canadian AI.

Fuelling Economic Growth

Since the announcement of the Pan-Canadian AI Strategy in March 2017, Canada has seen **significant growth in our AI ecosystem**.¹

TALENT CREATION²

 1,200+

graduate students and postdoctoral fellows trained at the AI Institutes (Amii, Mila and Vector Institute)

RESEARCH²



80

of the world's leading AI researchers named as Canada CIFAR AI Chairs, more than half of whom are new recruits to Canada

TALENT ATTRACTION³

 4th

in the world for AI skills migration, advancing 20 spots since 2015

FOREIGN DIRECT INVESTMENT^{2,4}

 45+

new AI R&D labs established in Canada by major multinational firms and **50% growth** in foreign direct investment in Canadian ICT

JOBS⁵

 3.6%

growth in tech employment, twice as fast as growth in other occupations

STARTUPS⁶

 \$658M

in venture capital funding to Canadian AI startups in 2019, a **49%** year-over-year increase



CANADA'S WORLD-CLASS AI TRAINING PROGRAMS ARE ATTRACTING GLOBAL TALENT

In the 1980s and 90s, three pioneering researchers came to Canada to pursue research in artificial intelligence. **Geoffrey Hinton** (Toronto), **Yoshua Bengio** (Montreal) and **Richard Sutton** (Edmonton) created centres of AI research in Canada and attracted top talent. These AI hubs established Canada's early successes in AI research and innovation. The Pan-Canadian AI Strategy continues to build on this foundation.

THREE CANADIAN UNIVERSITIES RANK WORLDWIDE IN THE TOP 25 MACHINE LEARNING PROGRAMS⁷

14th

University of Toronto

(home of the Vector Institute)

20th

University of Alberta

(home of Amii)

24th

Université de Montréal

(home of Mila)

CANADA'S THREE NATIONAL AI INSTITUTES ARE CREATING TRANSFORMATIVE SOCIETAL IMPACT

Amii is leveraging AI to address the climate crisis.

Amii [has been awarded \\$5 million over 2.5 years⁸](#) under the Government of Alberta's Ministry of Environment and Parks' Technology Innovation and Emissions Reduction (TIER) program. Partnering with industry, Amii will enable companies to leverage novel applications of AI that will have a measurable impact on emissions reduction.

Mila is leading the world in the responsible use of AI.

Mila researchers are contributing to a [new initiative⁹](#) to advance the responsible development of AI. The governments of Canada and Quebec announced a Montreal-based centre as part of the Global Partnership on Artificial Intelligence (GPAI) in June 2020. The GPAI facilitates international, multi-stakeholder collaboration to explore four themes, including how AI can be used in response to and recovery from COVID-19. Canada CIFAR AI Chair and Mila Scientific Director Yoshua Bengio serves as co-chair of the Working Group on Responsible AI.

The Vector Institute is driving excellence and leadership in AI.

The Vector Institute unveiled its [three-year strategy¹⁰](#) for driving excellence and leadership in AI. The strategy touches on four core areas: expanding research in a range of machine learning and deep learning topics; increasing partnerships with industry through programs for talent, training, and applied AI projects; enabling effective and appropriate research access to health data; and, contributing thought leadership on the economic and societal impacts of AI.

BUILDING A LEARNING HEALTH SYSTEM FOR CANADIANS

Canada's world-class AI research ecosystem is poised to revolutionize health care. Our diverse population and publicly funded health care system presents a unique opportunity for Canada to develop a national strategy that integrates state-of-the-art AI technologies into hospitals, clinical practices, and health systems. The result could improve health outcomes and reduce costs.

To capitalize on Canada's unique opportunity to integrate AI into health care, CIFAR led the AI for Health (AI4H) Task Force in September 2019. The AI4H Task Force included 17 leaders from the AI, health research, and innovation ecosystems, including co-chairs Professors David Naylor (**University of Toronto**) and Tim Evans (**McGill University**). The Task Force worked closely with Innovation, Science and Economic Development Canada and Health Canada to outline [recommendations¹¹](#) for an integrated, coordinated, and collaborative approach to AI4H in Canada.

THE TASK FORCE RECOMMENDS A NATIONAL AI FOR HEALTH STRATEGY TO:

- Reduce hospital and surgery wait times across Canada
- Allow more rapid diagnosis of diseases and conditions
- Allow doctors to spend more time with patients
- Support tailored treatment plans for individual patient needs
- Significantly reduce territorial and provincial health care costs
- Move novel Canadian-made products and services to the global market faster



Being a part of this brilliant group of researchers has given me the courage and support to take on the challenging research projects that I really aspire to tackle.

REIHANEH RABBANY,
Canada CIFAR AI Chair,
Mila

AI CO-PILOT IDENTIFIES COVID-19 IN CHEST X-RAYS



Mark Schmidt specializes in computer vision and machine learning applications at UBC's Department of Computer Science.

Canadian startup company 1QBit has developed a computer vision and machine learning approach to support physicians in the diagnosis of lung abnormalities on chest X-rays. XrAI is an AI "co-pilot" for physicians that improves the accuracy and consistency of chest X-ray interpretation and supports medical teams within their existing clinical workflow by identifying lung abnormalities on chest radiographs. Traditionally, a positive COVID-19 diagnosis results from a sinus swab and nucleic acid-based polymerase chain reaction test. However, the global demand for the test has put a strain on the supply chain, and the test is not universally available. Chest X-rays can confirm the presence of pneumonia, a primary symptom of COVID-19, and the respiratory symptom associated with the virus.

1QBit saw an important opportunity to apply their decision-support tool, XrAI, to COVID-19. The tool demonstrated a 100 per cent accuracy in identifying COVID-19 infections, and, as a result, is the first radiology AI software tool to be certified as a Class III Medical Device by Health Canada. Several Canadian health organizations are currently deploying it as part of Canada's Digital Supercluster COVID-19 program. The startup is working with partners in Canada and around the world to support them in the fight against COVID-19. This technology was developed in collaboration with Mark Schmidt, Canada CIFAR AI Chair, and Amii fellow, at UBC.

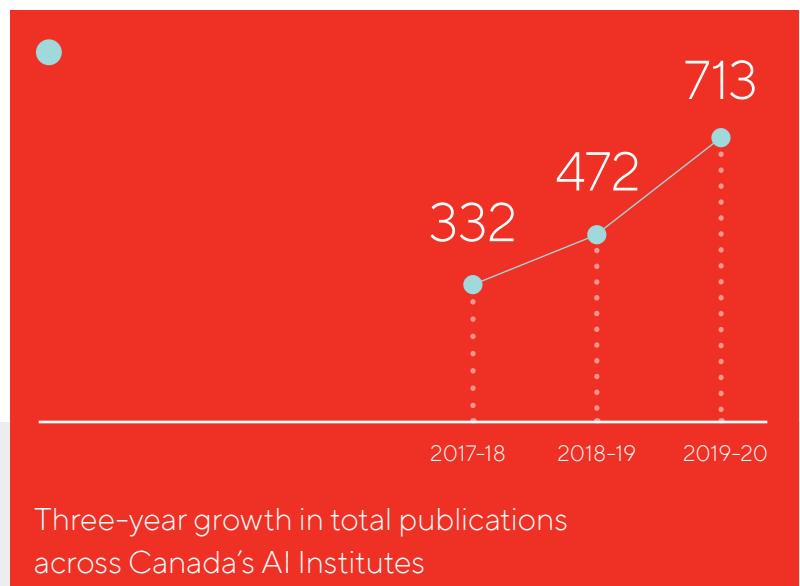
BUILDING A LEARNING HEALTH SYSTEM FOR CANADIANS

With the support of dozens of public- and private-sector organizations, the AI4H Task Force issued an urgent call to governments across Canada for collaboration on a national coordinated AI4H Strategy. Its recommendations¹² include:

- 1 Establishing an AI4H info-structure that enables responsible access to health data while ensuring data is secure and privacy is protected.
- 2 Accelerating the development of safe, high-performance AI4H applications by both public institutions and private enterprise, and deploying incentives that promote strategic procurement and responsible scaling of these applications within Canada's health care system.
- 3 Ensuring that federal and provincial/territorial plans to advance digital health are coupled to an explicit AI4H strategy with the relevant policies, investments, partnerships, and regulatory frameworks.

GROUNDBREAKING RESEARCH

Canada has a critical mass of AI researchers and trainees working at our three national AI Institutes.



Canada CIFAR AI Chairs

80 World-class AI researchers

44 Recruited to faculty positions in Canada¹³

36 Retained in Canada

14 Cross-appointed with industry

1,200 Student trainees across Canada

THE CANADA CIFAR AI CHAIRS ARE ADVANCING RESEARCH, TRAINING THE NEXT GENERATION OF AI LEADERS, AND GROWING R&D IN CANADA.



\$2.5 MILLION SUPPORTS LITERACY IN A MULTICULTURAL AND DIGITAL WORLD

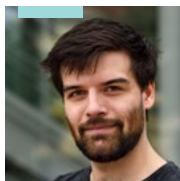
Alona Fyshe (Canada CIFAR AI Chair and CIFAR Fellow in the Learning in Machines & Brains program, Amii) was named co-recipient of a \$2.5 million grant with Janet Werker (University of British Columbia). Their project, “Ensuring Full Literacy in a Multicultural and Digital World,” brings together multidisciplinary experts to examine the emergence of new and existing technologies as they impact language, culture, and development. Fyshe and her collaborators will create two new brain imaging datasets to allow researchers to study how infants make meaning of words, and to compare the brain activity of children with different comprehension abilities.

DEVELOPING AI FOR GOOD IN LOW-INCOME COUNTRIES

Kevin Leyton-Brown (Canada CIFAR AI Chair, Amii) taught a course for graduate students about AI for social impact, using the UBC Farm as a case study. Students in the course developed a system that used commercial satellite images of fallow grasslands to predict soil moisture. The results can be used, in combination with existing climate and crop development models, to make irrigation recommendations and increase crop yields.

DEVELOPING ROBOTS FOR REAL-WORLD ENVIRONMENTS

Rupam Mahmood (Canada CIFAR AI Chair, Amii) is building systems that let robots work in uncertain environments. He is collaborating with Jonathan Kelly (University of Toronto Institute for Aerospace Studies STARS Lab). The team has produced a new visuomotor control task technique that allows robots to perform efficiently in uncertain, or real-world, environments, even when data are missing.



DESIGNING FAIR RECOMMENDATION SYSTEMS

Social media networks use graph embeddings to help connect us with people we may know, and entertainment providers like Netflix use them to generate tailored recommendations based on our past behaviour. **Will Hamilton (Canada CIFAR AI Chair, Mila)** and his team have previously highlighted unfair biases found in some of these systems, such as predictions or recommendations that unfairly bias based on race. This year, his team developed a framework for enforcing fairness constraints on graph embeddings.

WORLD-CLASS DEEP LEARNING LAB IN MONTREAL PLANS TO EXPAND

Simon Lacoste-Julien (Canada CIFAR AI Chair, Mila) is leading Samsung's SAIT AI Lab (SAIL) Montreal. Inaugurated in May 2019 within Mila's corporate space, this research lab has a mission to advance our fundamental understanding of deep learning technology and its applications. The lab has recruited research scientists from around the world, with plans to expand to 20 people over the next several years. Researchers at SAIL Montréal collaborate with Mila and the Montreal AI ecosystem, as well as with the Samsung Advanced Institute of Technology in Korea.

DEEP LEARNING TECHNOLOGY RAPIDLY DETECTS SIGNS OF MS IN MEDICAL IMAGING

Medical imaging is critical to the identification, monitoring and prognosis of many neurological diseases, including multiple sclerosis (MS). Traditionally, clinicians can detect signs of MS through the presence of lesions on medical imaging. Lesion segmentation poses a significant challenge to deep learning models and remains a barrier to the clinical adoption of machine learning in medical imaging. A team of researchers including **Tal Arbel** and **Doina Precup (both are Canada CIFAR AI Chairs at Mila)** have developed a 3D MS lesion segmentation convolutional neural network that yields promising results and could lead to rapid, reliable detection of current and new disease activity from patients' images, important for monitoring treatment efficacy.

GROUNDBREAKING RESEARCH



MACHINES CAN SOLVE PROBLEMS AND DEMONSTRATE REASONING

New research demonstrates that learning-structured memory, in the form of a reward machine (an automata-based structure) combined with reasoning procedure over such memory allows machines to solve difficult cognitive problems in a partially observable environment. **Rodrigo Toro Icarte**, a University of Toronto PhD student supervised by **Sheila McIlraith (Canada CIFAR AI Chair, Vector Institute)** authored a [research paper](#)¹⁴ presenting this approach to reinforcement learning (RL) in partially-observable environments (environments in which agents must rely on past experiences and memories). The work, which will set the stage for helping RL agents solve difficult cognitive problems in partially observable environments, was recognized with a prestigious spotlight presentation at NeurIPS 2019.

GOOGLE BRAIN TEAM COLLABORATION DEVELOPS SCALABLE REINFORCEMENT LEARNING

Reinforcement learning has gained prominence for its ability to teach AI agents to successfully predict actions based on trial and error. However, a major limitation is that RL requires a lot of data to learn from its environment, making it difficult to introduce into real-world environments. A collaboration between **Jimmy Ba (Canada CIFAR AI Chair, Vector Institute)** and the Google Brain Team has led to the creation of [Dreamer](#)¹⁵, a model-based RL agent that learns from a simplified world model. Relying on backpropagation, it uses images to predict outcomes from a set of hypothetical actions. This collaboration is a significant breakthrough in rapid scaling of RL agents.

HELPING AI AGENTS TO BECOME RISK-AWARE

Amir-massoud Farahmand (Canada CIFAR AI Chair, Vector Institute) has developed the Characteristic Value Function (CVF), a new RL framework to represent the uncertainty of an AI agent's future rewards. This representation allows the agent to compute the risk of its decisions, which is important for applications in health care or finance where the agent should be risk-aware and avoid catastrophically bad outcomes. CVF enables the development of such risk-aware agents.



Angel Chang

IS TEACHING MACHINES TO SEE THE WORLD IN 3D

Angel Chang is laying the groundwork for AI technologies that will make human–robot interaction more natural. With robotic agents already on the ground on some factory floors, Chang’s research will support future applications that enable robotic agents to interact in a 3D world.

A Canada CIFAR AI Chair and fellow at Amii, Chang specializes in natural language processing, an AI technique that teaches machines to understand and process the language of humans. Her research is generating text to 3D scenes.

The 3D world is a complex one, for both humans and robotic agents, and requires a degree of common sense that doesn’t come naturally for AI agents. If a person is asked to think about a room with a coffee table and a sofa, it’s common sense for them to assume the coffee table will be in front of the sofa, but current robotic agents aren’t able to make that assumption yet.

“We all have slightly different sensory perceptions of the world. My focus is to try and bring these two strands together – so that language connects with images, but in 3D representation because that’s the world we live in,” says Chang. Chang is an assistant professor at Simon Fraser University.



Sanja Fidler

IS TAKING DATA TO THE NEXT LEVEL WITH AN AI-ASSISTED ANNOTATION TOOL

Sanja Fidler is helping researchers scale their AI innovations by creating an AI-assisted tool that can rapidly and accurately label large amounts of data.

A Canada CIFAR AI Chair and faculty member of the Vector Institute, Fidler specializes in computer vision, specifically in 2D and 3D object detection. She is also an associate professor at the University of Toronto and a director of NVIDIA's Toronto AI Lab.

Traditionally, data labelling, or annotation, is a laborious process undertaken by humans. Fidler says it takes a long time and can become incredibly tedious and prone to fatigue-related errors. However, labelling the data is essential for training robust algorithms.

"Data is really the lifeblood of machine learning," she explains. "Without data, there is no machine learning. In a lot of machine learning domains, especially in computer vision, labelling data becomes a huge bottleneck." She adds that in some cases data collection and labelling make up the majority of a project's time and expense. According to Fidler, some companies may opt for less data and therefore poorer performing algorithms in order to meet project/prototype deadlines.

Fidler and her team of students at the University of Toronto were inspired to create an annotation platform that could help industry and academia scale their products and services.

"We decided to create software that was going to take all of these techniques that we've developed in the lab and incorporate them into an AI-assisted labelling platform that researchers and companies can actually use," she says.

The application automatically completes the tasks of segmenting pixels and labeling objects, which are important for many different applications, including medical imaging and self-driving cars.

Fidler's research could significantly speed up this important process. "If it took you a few weeks to label a million images, we envision you could be able to label ten to a hundred million images at the same time in the future," she says.

Fidler was awarded the Connaught Innovation Award for her work in AI-assisted annotation in 2020.



Sarath Chandar

IS DEVELOPING LIFELONG LEARNING IN MACHINES

A significant limitation in current generations of machine learning systems is that once they are trained and deployed in a specific setting, they aren't able to continue learning. Canada CIFAR AI Chair Sarath Chandar builds continuous learning systems. His research has huge implications for self-driving cars, and even medical applications, such as those that detect cancer from medical imaging.

"Some of these systems become outdated and have to be retrained every few weeks. Every time you have to retrain a system, it uses a lot of computational resources and takes time," he explains.

Chandar is an academic core member of Mila, the Quebec Artificial Intelligence Institute, and an assistant professor at École Polytechnique de Montréal. "My long-term vision is to build lifelong learning systems that can learn by interacting with humans and by communicating in the natural language of humans," he says.

Chandar is also collaborating with 99andBeyond, a Canadian-based AI drug discovery startup, to use a reinforcement learning-based agent to identify drugs that can target COVID-19. The agent will be able to produce and synthesize drugs to accelerate drug discovery, a process that typically takes several years.

Being part of the Canada CIFAR AI Chairs program has allowed me to focus on my research, and the flexibility to hire excellent people as soon as I find them, rather than having to try and secure funding first. This changes the timescale of research, because you can start working on ideas right away, and quickly iterate towards the best solutions.

ALONA FYSHE,
Canada CIFAR AI Chair,
Amii; CIFAR Fellow,
Learning in Machines
& Brains

“



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AI & COVID-19

Harnessing the power of AI to address the COVID-19 pandemic

On March 11, 2020, the World Health Organization declared the COVID-19 pandemic. Since then, the world has experienced profound change as countries closed their borders, declared nationwide lockdowns and implemented policies around social distancing and the mandatory wearing of masks. CIFAR and the AI institutes – Amii, Mila and the Vector Institute – acted swiftly to convene global AI expertise in the fight against COVID-19.

14 AI RESEARCH PROJECTS TO ADDRESS COVID-19

On March 23, 2020, CIFAR launched the AI and COVID-19 Catalyst Grants, a call for projects using AI to address the COVID-19 pandemic. The grant recipients explore a range of topics, including using medical imaging and AI to predict how sick someone will become following COVID-19 infection, understanding how the virus is mutating as it is transmitted through the population, and studying the mental health impacts of COVID-19.

CIFAR'S AI AND COVID-19 CATALYST GRANTS PROGRAM WAS FUNDED IN PART BY:

Government of Ontario

Microsoft (AI for Health program)

Natural Sciences and Engineering Research Council of Canada

Genome Canada

Max Bell Foundation

Individual donors



TRACKING MENTAL HEALTH DURING THE COVID-19 PANDEMIC

Alona Fyshe, Canada CIFAR AI Chair (Amii), fellow in CIFAR's Learning in Machines & Brains program, and assistant professor at the University of Alberta, is working with a team of computer scientists to apply AI techniques to social media to better understand the effects of the COVID-19 pandemic. She is interested in the impacts of home-schooling, unemployment, and social distancing on our mental health.

The goal is to build a tool that can detect the drivers of mental health issues associated with the pandemic, and in the event of a second wave, prepare and anticipate techniques to cope with them. "This will build on our work that looks at discourse within vulnerable populations on social media," says Dan Lizotte, one of the project collaborators based at Western University.

USING AI TO FIND EFFECTIVE, ALREADY-APPROVED COVID-19 DRUGS

A team including Jian Tang, Will Hamilton, and Yoshua Bengio (all three are Canada CIFAR AI Chairs at Mila) is using machine learning to find drugs that affect the same proteins targeted by COVID-19. They are searching for drug candidates in a similar way to how social networks recommend friends. "In social networks, for example, you want to recommend friends based on existing links," says Tang. "In this case, it's the same intuition. Based on the existing links between the drugs and proteins and the proteins and disease, we try to predict new links."

USING AI TOOLS TO PREDICT A SAFE REOPENING OF THE ECONOMY

Frank Wood (Canada CIFAR AI Chair, Mila) and a team of researchers at the Programming Languages for Artificial Intelligence Research Group at UBC are investigating how to automate parts of pandemic policy-making. Using existing epidemiological models, the team has shown how to use software to automatically determine which policies, including hand-washing, mask-wearing, social distancing, and school closures, to put in place to reopen quickly and safely.

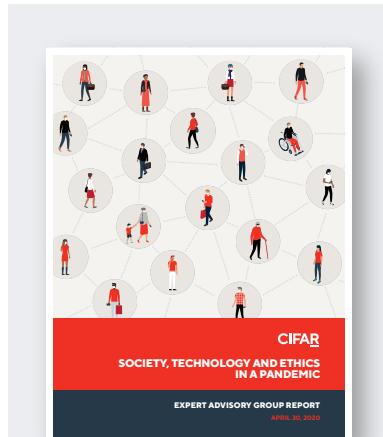
"Every model that we've seen implies that COVID-19 is going to be with us for some time," says Wood, an associate professor at UBC and an associate member of Mila. "Our aim is to inform epidemiologists and policy-makers about the most advanced tools and techniques available."

MOBILIZING EXPERTISE TO ADDRESS COVID-19

The COVID-19 pandemic highlighted the need for governments, experts, and scientists from around the world to come together to harness the power of AI technologies. CIFAR led the charge, bringing together experts from around the world and publishing actionable insights.

International Roundtable on AI and COVID-19¹⁶

Seventy Canadian and international leaders in AI, business, infectious disease, epidemiology, and medicine were brought together to explore opportunities for collaboration and data sharing. Their [report](#)¹⁷, complete with policy-relevant insights, was shared at a subsequent virtual policy briefing of more than 50 policy-makers and health officials from federal and provincial governments across Canada, the U.S., and the U.K. As a result, the Statistics Research Institute at Statistics Korea organized a virtual meeting with G20 leaders to take decisive actions together in public health, data sharing, medical treatment, and vaccine development.



At the request of Canada's Chief Science Advisor, CIFAR established an expert advisory group to consider the technical, social, legal and ethical implications of novel technologies deployed in response to COVID-19, with a particular focus on contact-tracing apps. CIFAR published [Society, Technology and Ethics in a Pandemic \(STEP\)](#),¹⁸ a report outlining the group's recommendations and guiding principles.



Candice Odgers, co-lead for the AI & Society workshop Generation AI and CIFAR Fellow, in the Child & Brain Development program, explores potential risks and opportunities for youth growing up in the digital age.

AI & SOCIETY

Understanding how AI applications will affect our lives

The AI & Society program develops global thought leadership on the economic, ethical, policy and legal implications of advances in artificial intelligence. This year we worked with international organizations and national governments around the world to lead global policy conversations and bridge the divide between powerful AI technologies and the policies that will ensure their responsible use.

WE GENERATED A DEEPER UNDERSTANDING OF HOW AI IMPACTS HEALTH, SECURITY AND CULTURE THROUGH EIGHT AI & SOCIETY WORKSHOPS.

At one workshop, a team of experts led by Amy Luers (Future Earth) explored opportunities where AI can be applied to combat climate change. They published [an initial framework for leveraging digital technology for sustainability¹⁹](#) in March 2020 and the [Montreal Statement on Sustainability in the Digital Age²⁰](#) in summer 2020, calling for a global collaboration among business, civil society, researchers, and innovators to use AI to help build a sustainable and equitable world.

Another workshop, led by Candice Odgers, Fellow in CIFAR's Child & Brain Development Program, examined the use of online algorithms and their impact on child development, particularly on youth exposed to high levels of poverty and inequality. The team's [research²¹](#) was featured in [The New York Times²²](#) in January 2020.

**WE EXAMINED THE
FUTURE OF WORK,
DATA GOVERNANCE
AND REGULATORY
INNOVATION FOR
CANADA AND THE U.S.**

CIFAR hosted a roundtable and panel discussion in January 2020 in partnership with Innovation, Science and Economic Development Canada and the U.S. Department of State, to consider innovative public policy²³ to develop competitive AI strategies for economic growth, while mitigating potential societal risks for both countries.



CIFAR President
& CEO Dr. Alan
Bernstein invites AI
and policy experts
from Canada and the
U.S. to collaborate
on AI innovation
for the benefit of
both countries.

WE CREATED A GLOBAL SNAPSHOT OF THE RAPIDLY EVOLVING TECHNOLOGY POLICY LANDSCAPE.

The second edition of *Building an AI World: Report on National and Regional Strategies*²⁴ highlighted that countries with national AI strategies continue to be concentrated among the advanced economies of Western Europe, North America and East Asia. New strategies also tend to be more comprehensive, addressing most or all of eight major policy areas (research, talent development, skills, industrial policy, ethics, data & digital infrastructure, AI in government, and inclusion).



Since the launch of the first edition in 2018, 15 of the world's largest economies have developed, or are in the process of developing, a national AI strategy.

CONNECTIONS MADE THROUGH CIFAR'S AI & SOCIETY PROGRAM



354
Participants



20
Countries represented



10
AI & Society events and workshops

7

Publications
on AI's impact
on society

Generation AI:
Establishing
Global Standards
for Children
and AI²⁵

Generation AI:
Wearables,
Mental Health
and Child
Development²⁶

AI-Powered
Information
Ecosystems &
Democracy²⁷

Regulation of
Defense and
Security AI
Technologies:
Options Beyond
Traditional Arms
Control²⁸

Regulation of
Defense and
Security AT
Technologies:
Regulatory
Options for AI
Technologies²⁹

Sustainability
in the
Digital Age³⁰

AI,
Recommend-
ations & the
Curation of
Culture³¹



Available at
cifar.ca/ai/ai-society

CIFAR ENGAGED NINE INSTITUTIONAL PARTNERS TO ADVANCE GLOBAL UNDERSTANDING OF AI & SOCIETY

14TH

- B.C. Ministry of Health
- Innovation, Science and Economic Development Canada
- U.K. Research and Innovation (UKRI)
- French National Centre for Scientific Research (CNRS)
- RAND Corporation
- UN Institute for Disarmament Research
- Future Earth
- Schwartz Reisman Institute for Technology and Society, University of Toronto
- U.S. State Department

CENTRING INDIGENOUS PERSPECTIVES IN DESIGNING AI

Indigenous researchers and experts from around the world have teamed up to publish “Indigenous Protocol and Artificial Intelligence,” [a position paper](#)³² that provides a starting place for designing ethical AI through an Indigenous-centred approach.

The Indigenous Protocol & AI workshop team, supported by the [CIFAR AI & Society Program](#),³³ developed the paper following discussions that took place over 20 months and across 20 time zones. Those discussions included two workshops which brought together people from Indigenous communities across Aotearoa (New Zealand), Australia, North America, and the Pacific Region.

The paper offers a range of ideas, questions and approaches to be considered when centring Indigenous knowledge in the development of AI.

“Many of the guidelines and manifestos that are coming out mostly centre around the human, which is not in alignment with most Indigenous methodologies,” explains Jason Edward Lewis, a professor in Concordia University’s Design and Computation Arts department. Lewis is of Hawaiin-Samoan descent and is a member of the workshop leadership group.

“We as a society allow AI to collect our data and make decisions that impact us, so we should develop an understanding of what kind of relationship we want to have with AI,” says Lewis. “Is AI a slave to a human master, or do we want to create intelligent systems with respect? It’s a better world for all of us if we treat these systems with respect, and teach them to treat us with respect,” says Lewis.



Participants discussed how Indigenous knowledge can support ethical AI.

From left to right:
Michelle Lee Brown,
Brent Barron,
Prof. Noelani Arista,
Prof. Jason Edward Lewis,
Suzanne Kite,
Dr. Ōiwi Parker Jones,
Angie Abdilla,
Prof. D. Fox Harrell,
Marlee Silva



"The protocols that many of our Indigenous cultures have developed to respectfully deal with non-humans could be a pathway to try and understand what we are using AI to create and why," says Lewis.

The position paper features a collection of heterogeneous texts that include design guidelines, scholarly essays, artwork, descriptions of technology prototypes, and poetry. Together they examine AI through different Indigenous epistemologies and technological practices.

Caroline Running Wolf, née Old Coyote is a PhD student at the University of British Columbia, a member of the Apsáalooke Nation (Crow), and one of the contributors to the position paper. Her PhD research with the Kwakwaka'wakw on North Vancouver Island, B.C. explores how immersive technologies can support Indigenous language and culture reclamation efforts.

"AI is built by engineers that do not represent a cross cut of society. When we talk about data, for Indigenous communities, it's not just about bits and bytes, it's the sacred stories and voices of our ancestors," she says.



The Indigenous Protocol & AI workshop was co-led by Jason Lewis (Concordia University).

Above: IP AI participants share ideas about the relationship between humans and AI.

*IP AI. Āina Paika.
Courtesy of Initiative for Indigenous Futures.*



NATIONAL PROGRAM OF ACTIVITIES



Above: Students at the 2018 Deep Learning + Reinforcement Learning Summer School, hosted by the Vector Institute in Toronto, Ont.

Left: Students explore what Canada has to offer at the 2018 summer school's sponsor booths.



Students at the 2019 DLRL Summer School, hosted by Amii in Edmonton, Alta., take in a session by Reinforcement Learning pioneer Rich Sutton.

AI4GOOD: TRAINING THE NEXT GENERATION OF AI LEADERS

CIFAR is committed to equity, diversity and inclusion in AI. Under the CIFAR AI4Good National Training program, CIFAR and its partners engage more than 800 students and trainees every year, from high school students to postdoctoral fellows in Canada and from around the world, to help them develop the skills, expertise, and networks that they will need to be successful in their future careers.

This year, we offered many of our AI training programs virtually to ensure continued access to AI training opportunities during the pandemic.

IN 2020, THE PAN-CANADIAN AI STRATEGY SUPPORTED:

- CIFAR DLRL Summer School, hosted by Mila
- CIFAR OSMO AI4Good Lab
- Simon Fraser University Invent the Future: AI Scholars Program
- University of British Columbia Data Science for Social Good Fellowship Program
- IVADO-Mila International Summer School on Bias and Discrimination in AI
- Oxford Machine Learning Summer School

CIFAR OSMO AI4GOOD SUMMER LAB

The AI4Good Summer Lab promotes inclusive tech culture by empowering women in AI. The program is designed for undergraduate women enrolled in STEM programs and provides hands-on, collaborative learning experiences.

The 2020 Summer Lab was held virtually from June 6 to July 28, 2020. In the final three weeks of the program, the women divided into groups to develop AI prototypes that could be used for social good, in a competition to be judged by AI experts. Two winning teams received two months of extended project support to develop their prototypes, and \$2,000 in funding provided by Concertation Montréal.



ACADEMIC WINNER

EthicAI analyzes how less-examined biases, such as ageism, may have been incorporated into Facebook's fastText natural language processing toolset.

ENTREPRENEURIAL WINNER

newsworthy.ml is a web platform that improves and informs a user's news-reading experience by increasing the visibility of underrepresented news and providing analytics about a user's news-reading behaviour.

Students from the 2019 AI4Good Lab in Montreal developed AI projects to make the world a better place.

CIFAR DEEP LEARNING + REINFORCEMENT LEARNING (DLRL) SUMMER SCHOOL

The CIFAR DLRL Summer School is the only international AI training program in the world. Every year, thousands of students from around the world apply for the CIFAR DLRL Summer School. Top applicants come to Canada to learn from world-class AI pioneers such as Yoshua Bengio, Richard Sutton and Doina Precup.

In August 2020, CIFAR, in partnership with Mila, hosted the first-ever virtual edition of the DLRL Summer School. Students participated in five days of virtual programming which included breakout sessions, one-to-one meetings, virtual socials, and panel discussions on AI, ethics, and career options.

2020 By the Numbers



The AI4Good training programs aim to foster connections between students, as well as industry and research leaders.



25

World-class AI speakers

5,000+

Online conversations

● IN A SURVEY OF DLRL STUDENTS



31%

Identified as women

12%

Identified as visible minorities

14th

“



CIFAR has long demonstrated a commitment to supporting foundational research in computer science and AI, as exemplified by the deep learning revolution. I appreciate the support the Canada CIFAR AI Chair provides in being able to work on research whose impact will be realized many years down the road.

ROGER GROSSE,
Canada CIFAR AI Chair,
Vector Institute

”

Above: 2020 DLRL students tuned in from all over the world, participating in breakout sessions, one-to-one meetings and lecture-style webinars.

“



The Canada CIFAR AI Chairs program allows professors and researchers the funds and the flexibility to do what we do best: pursue high quality research and train tomorrow's leaders in the field.

AARON COURVILLE,
Canada CIFAR AI Chair,
Mila; CIFAR Fellow,
Learning in Machines
& Brains

”



Chris Maddison,
Aishwarya Agrawal,
Csaba Svepesvari,
and Elissa Strome
share their goals for
the future of research
at AICan 2019.

CATALYZING COLLABORATION AND NEW AREAS OF RESEARCH

The CIFAR AI Catalyst Grants were created as part of the Pan-Canadian AI Strategy's National Program of Activities to support cross-collaboration among Canada's top AI scientists and inspire high-risk, high-reward areas of research.

Nine projects were funded through the CIFAR AI Catalyst Grants program. The projects explore a range of topics, from theoretical to applied research, including:

- the theoretical investigation of modern machine learning algorithms;
- a Parkinson's treatment that uses machine learning and rhythmic auditory stimulation to help patients walk;
- the study of natural language and complex tasks;
- and, the prediction and control of the future state of an AI system, among others.

Two projects were funded in partnership with the RBC Foundation to support research in the areas of privacy, accountability, transparency, and bias in machine learning.

ACKNOWLEDGMENTS

Special thanks to our partners for their support and contribution:

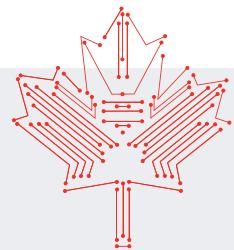
Amii

Mila

Vector Institute

CIFAR's leadership of the Pan-Canadian AI Strategy is funded by the Government of Canada, Facebook and the RBC Foundation.

Canada **facebook**



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ON THE PAN-CANADIAN
AI STRATEGY**



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Endnotes

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- ¹² <https://www.cifar.ca/ai/pan-canadian-artificial-intelligence-strategy/building-a-learning-health-system-for-canadians>
- ¹³ Figure represents researchers who were recruited to Canada and those who accepted their first faculty positions in Canada.
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- ³² <https://spectrum.library.concordia.ca/986506/>
- ³³ <https://www.cifar.ca/ai/ai-society>

APPENDICES

APPENDIX A: CANADA CIFAR AI CHAIRS

Canada CIFAR AI Chair	Academic Institution	Other Affiliations	AI Institute
Aishwarya Agrawal	Université de Montréal		Mila
Tal Arbel	McGill University		Mila
Alán Aspuru-Guzik	University of Toronto		Vector
Jimmy Ba	University of Toronto		Vector
Pierre-Luc Bacon	Université de Montréal		Mila
Marc Bellemare	McGill University	Google Brain, Montréal	Mila
Shai Ben-David	University of Waterloo		Vector
Yoshua Bengio	Université de Montréal		Mila
Danilo Bzdok	McGill University		Mila
Juan Felipe Carrasquilla	University of Waterloo		Vector
Sarath Chandar	École Polytechnique de Montréal		Mila
Angel Chang	Simon Fraser University		Amii
Laurent Charlin	HEC Montréal		Mila
Jackie Cheung	McGill University		Mila
Aaron Courville	Université de Montréal		Mila
Fernando Diaz	McGill University	Microsoft Research, Montréal	Mila
Marc-Antoine Dilhac	Université de Montréal		Mila
Christophe Dubach	McGill University		Mila
Audrey Durand	Université Laval		Mila
Murat Erdogdu	University of Toronto		Vector
Amir-massoud Farahmand	University of Toronto		Vector
Sanja Fidler	University of Toronto	NVIDIA, Toronto AI Lab	Vector
David Fleet	University of Toronto	Google Brain, Toronto	Vector
Jakob Foerster	University of Toronto		Vector
Alona Fyshe	University of Alberta		Amii
Christian Gagné	Université Laval		Mila
Animesh Garg	University of Toronto	NVIDIA	Vector
Pascal Germain	Université Laval		Mila
Marzyeh Ghassemi	University of Toronto		Vector
Anna Goldenberg	University of Toronto	SickKids Research Institute	Vector

Canada CIFAR AI Chair	Academic Institution	Other Affiliations	AI Institute
Geoffrey Gordon	McGill University	Microsoft Research, Montréal	Mila
Roger Grosse	University of Toronto		Vector
William Hamilton	McGill University		Mila
Simon Lacoste-Julien	Université de Montréal	Samsung Institute of Technology AI Lab, Montréal	Mila
Hugo Larochelle	Université de Montréal	Google Brain, Montréal	Mila
François Fleuret	Université Laval		Mila
Nicolas Le Roux	McGill University	Google Brain, Montréal	Mila
Kevin Leyton-Brown	University of British Columbia		Amii
Chris J. Maddison	University of Toronto		Vector
Rupam Mahmood	University of Alberta		Amii
Alireza Makhzani	University of Toronto		Vector
Sheila McIlraith	University of Toronto		Vector
Ioannis Mitliagkas	Université de Montréal		Mila
Quaid Morris	University of Toronto		Vector
Sara Mostafavi	University of British Columbia		Vector
Lili Mou	University of Alberta		Amii
Tim O'Donnell	McGill University		Mila
Sageev Oore	Dalhousie University		Vector
Christopher Pal	Ecole Polytechnique de Montréal	Element AI	Mila
Nicolas Papernot	University of Toronto		Vector
Courtney Paquette	McGill University		Mila
Liam Paull	Université de Montréal		Mila
Gennady Pekhimenko	University of Toronto		Vector
Joelle Pineau	McGill University	Facebook AI Research, Montréal	Mila
Toniann Pitassi	University of Toronto		Vector
Pascal Poupart	University of Waterloo		Vector
Doina Precup	McGill University	DeepMind, Montréal	Mila
Reihaneh Rabbany	McGill University		Mila
Guillaume Rabreau	Université de Montréal		Mila
Siamak Ravanbakhsh	McGill University		Mila
Siva Reddy	McGill University		Mila
Blake Richards	McGill University		Mila
Irina Rish	Université de Montréal		Mila
Daniel Roy	University of Toronto		Vector

Canada CIFAR AI Chair	Academic Institution	Other Affiliations	AI Institute
Frank Rudzicz	University of Toronto	Li Ka Shing Knowledge Institute, St Michael's Hospital, Toronto	Vector
Mark Schmidt	University of British Columbia		Amii
Angela Schoellig	University of Toronto		Vector
Leonid Sigal	University of British Columbia		Vector
Nathan Sturtevant	University of Alberta		Amii
Csaba Szepesvári	University of Alberta	DeepMind, Edmonton	Amii
Jian Tang	HEC Montréal		Mila
Graham Taylor	University of Guelph		Vector
Martin Vallières	Université de Sherbrooke		Mila
Pascal Vincent	Université de Montréal	Facebook AI Research, Montréal	Mila
Bo Wang	University of Toronto	Peter Munk Cardiac Centre, University Health Network, Toronto	Vector
Adam White	University of Alberta		Amii
Martha White	University of Alberta		Amii
Frank Wood	University of British Columbia		Mila
James Wright	University of Alberta		Amii
Yaoliang Yu	University of Waterloo		Vector

APPENDIX B: SELECTED AWARDS AND HONOURS EARNED BY CIFAR AI RESEARCHERS IN 2019-20

AWARDS

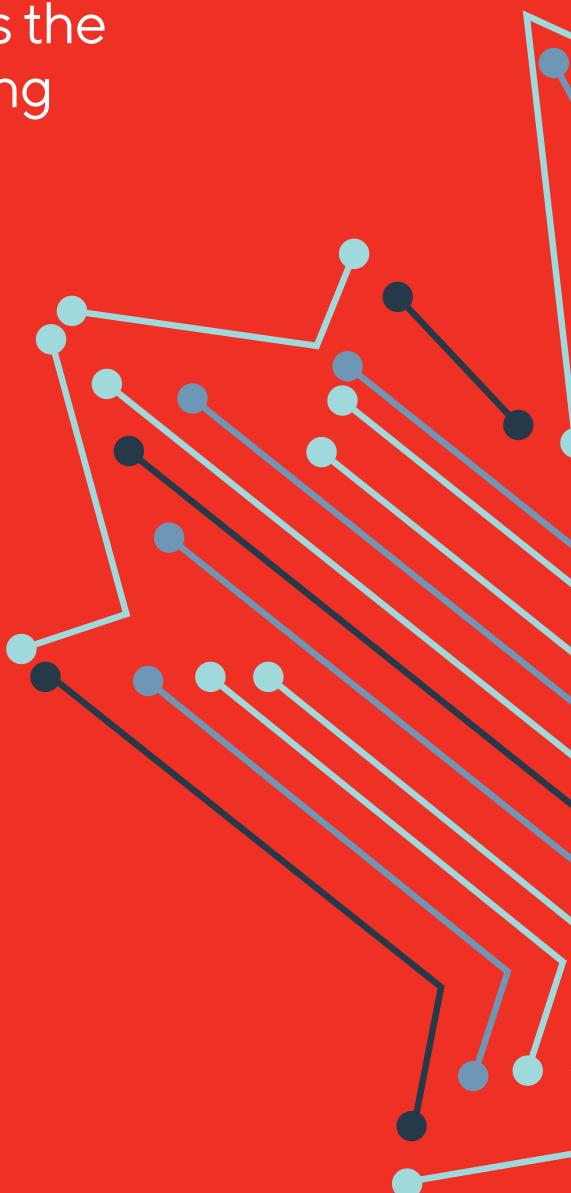
Award	Recipient and Institution
AI 2000 Most Influential Scholars – Machine Learning 2020 (Top 10, By Category) (AMiner, Tsinghua University, China)	<p>Machine Learning:</p> <ul style="list-style-type: none"> • Jimmy Ba (University of Toronto and Vector Institute) • Yoshua Bengio (Université de Montréal and Mila) • Aaron Courville (Université de Montréal and Mila) • Geoffrey Hinton (University of Toronto, Vector Institute and Google Research)
	<p>Natural Language Processing:</p> <ul style="list-style-type: none"> • Yoshua Bengio (Université de Montréal and Mila)
	<p>Speech Recognition:</p> <ul style="list-style-type: none"> • Geoffrey Hinton (University of Toronto, Vector Institute and Google Research)
Creative Destruction Lab Idea Award (Canada)	<ul style="list-style-type: none"> • Alán Aspuru-Guzik (University of Toronto and Vector Institute)
Discovery Accelerator Supplement Award (Natural Sciences and Engineering Research Council, Canada)	<ul style="list-style-type: none"> • Blake Richards (McGill University and Mila)
Early-Career Spotlight Award (Robotics: Science and Systems Foundation, U.S.)	<ul style="list-style-type: none"> • Angela Schoellig (University of Toronto and Vector Institute)
Facebook PyRobot: Democratizing Robotics Research Award (U.S.)	<ul style="list-style-type: none"> • Liam Paull (Université de Montréal and Mila)
Google Quantum Research Award (U.S.)	<ul style="list-style-type: none"> • Juan Felipe Carrasquilla (University of Waterloo and Vector Institute)
Lifetime Achievement Award (Canadian Image Processing and Pattern Recognition Society)	<ul style="list-style-type: none"> • David Fleet (University of Toronto and Vector Institute)
NSERC-Google Industrial Research Chair in Quantum Computing (Canada)	<ul style="list-style-type: none"> • Alán Aspuru-Guzik (University of Toronto and Vector Institute)

HONOURS

Honour	Recipient and Institution
Fellow of the Association of Computing Machinery (U.S.)	<ul style="list-style-type: none"> • Sheila McIlraith (University of Toronto)
Fellow of the Royal Society (U.K.)	<ul style="list-style-type: none"> • Yoshua Bengio (Université de Montréal and Mila)



CIFAR is a Canadian-based global research organization that convenes extraordinary minds to address the most important questions facing science and humanity.



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