

APRIL 2019 – MARCH 2020

ANNUAL REPORT

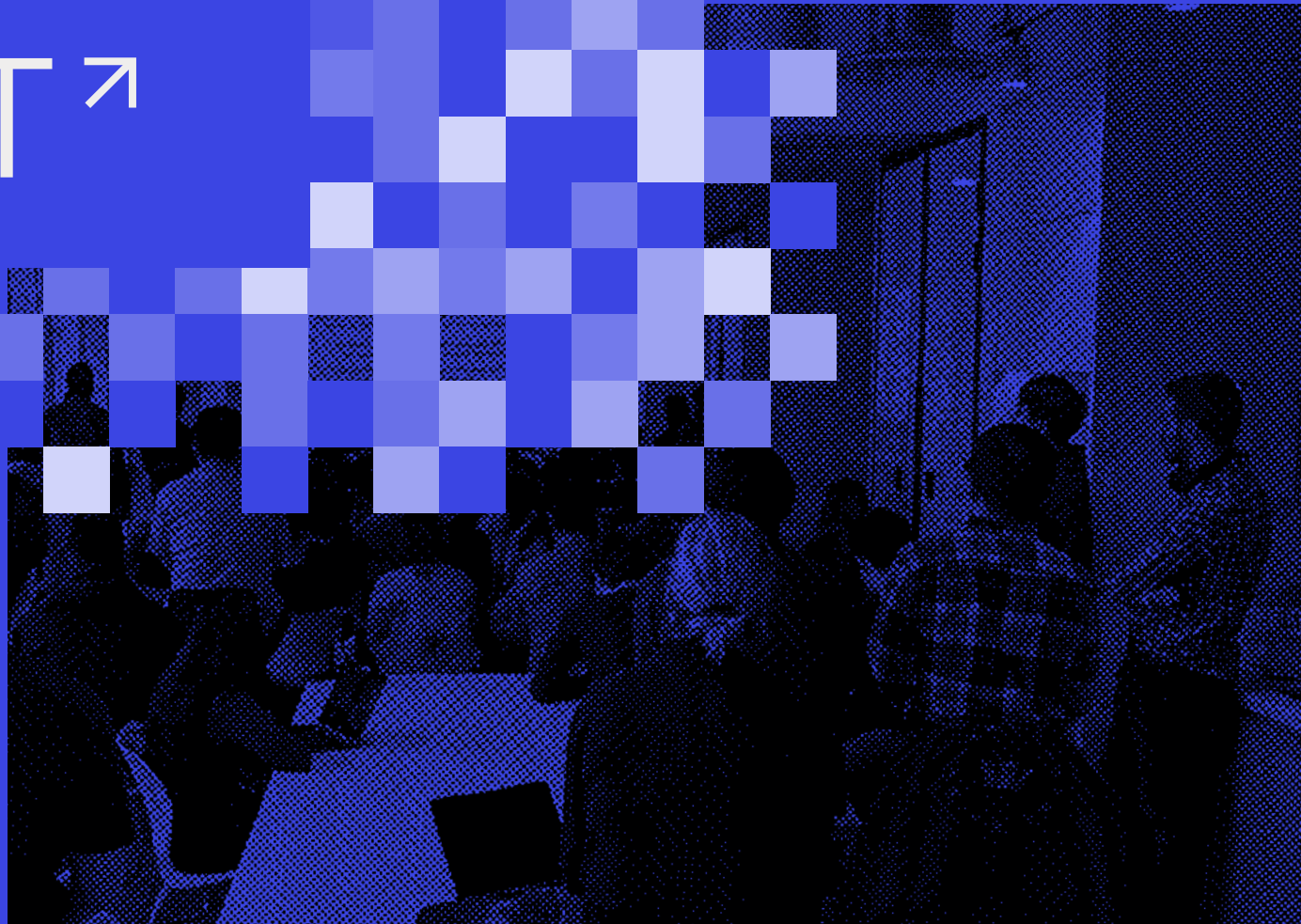


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MESSAGE FROM THE BOARD CHAIR AND THE PRESIDENT AND CEO

When the Vector Institute launched three years ago, Canada faced a vexing problem. Despite having invested in world-class machine and deep learning research, AI talent was scarce, and the global competition to hire AI practitioners and commercialize applications was intensifying

Our founders advanced into a bold vision: that Vector would attract and retain world-leading AI researchers to Toronto and create a positive feedback loop of talent attraction and investment. The intersection of academia, institutions, and businesses would allow Canadians to share in the economic and social benefits promised by widespread AI adoption.

This report marks our third year of progress towards that vision. We have grown into a diverse community of over 500 AI researchers, whose work is frequently presented at the world's top conferences and

journals, and an ever-expanding community of alumni and practitioners. This past year saw Vector competing once again with some of the world's top labs to successfully recruit new Faculty Members. Working with universities across the province, we also significantly expanded the pipeline of workforce-ready master's students: in 2019-20, over 1,000 AI master's students were enrolled in a combination of Vector-recognized programs and individual AI study paths.

Vector's community of AI talent is the bedrock for programs that enable Canadian companies to build teams and expertise that help them to enhance processes and products within their organizations. This year, we enrolled over 900 industry practitioners in professional development and upskilling programs. We also led six collaborative projects where participants from 25 different companies convened on topical questions about fairness and governance and experimented with developing their own natural language processing models.

Just as industry must overcome challenges to operationalize AI, so too must our public health system. We have continued to work with hospitals and institutions to lay the groundwork for appropriate research access to health data through secure computing environments and governance frameworks that promote innovation while

upholding privacy. We will build on these necessary first steps towards efficient and innovative care.

While this report describes the Vector Institute's accomplishments over the last year, the most promising advancements have occurred within our partner organizations. Just a few years ago, many businesses, policymakers, and clinicians in Canada questioned how AI might affect their strategic directions. Today, they are embracing it as a strategic underpinning and have begun to engage at the operational level: they want to know who to hire, how to build a team, move research into deployment, and adapt governance practices to implement fair and responsible models.

Vector's new Three-Year Strategy endeavors to enable progress on all these fronts, including through the addition of new AI engineering capacity. Amplifying our researchers' work through open source tools and frameworks that make scaling and applying AI easier will be key to our collective success and positioning Canada as a global leader in AI.

As this report is being published, our staff and researchers find themselves physically distanced due to the COVID-19 pandemic. Yet, thanks to the foresight of our founders – including the Government of Canada through the CIFAR Pan-Canadian AI Strategy, Province of Ontario, and

dozens of Canadian businesses – our position as a central pillar of Canada's AI ecosystem is strong. As businesses and institutions look to AI to adapt, innovate, and compete, we are ramping up our readiness to help them succeed.



Ed Clark

Chair of the Board of Directors



Garth Gibson

President and CEO

OUR VISION

The Vector Institute will drive excellence and leadership in Canada's knowledge, creation, and use of AI to foster economic growth and improve the lives of Canadians.

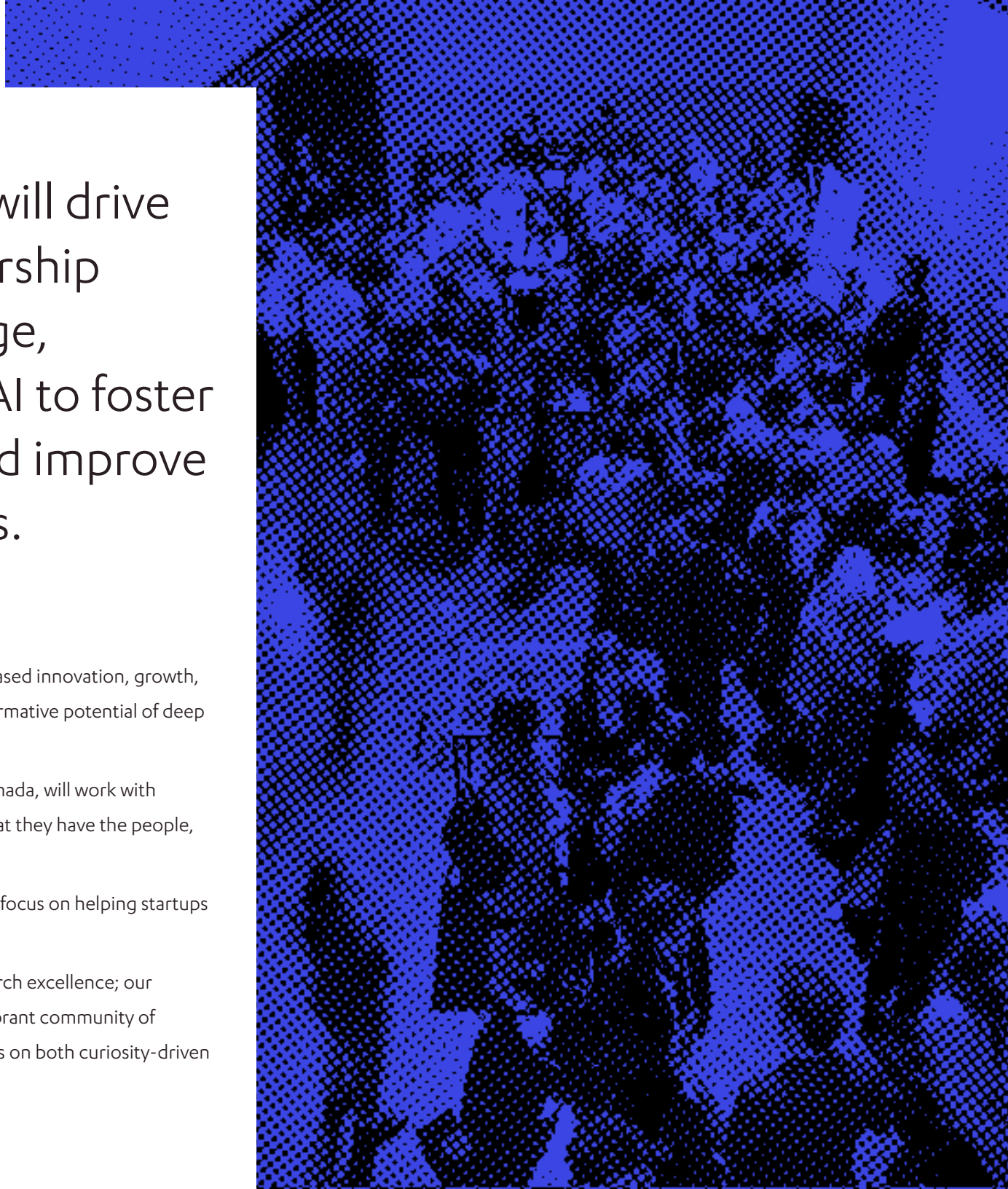
OUR MISSION

We will lead Ontario's efforts to build and sustain AI-based innovation, growth, and productivity in Canada by focusing on the transformative potential of deep learning and machine learning.

We, together with our AI partners in other parts of Canada, will work with Canadian industry and public institutions to ensure that they have the people, skills, and resources to be best in class at the use of AI.

We will support Canada's innovation clusters in AI and focus on helping startups grow to become Canadian-based global leaders.

We will attract the best global talent focused on research excellence; our researchers and academic partners will be part of a vibrant community of innovative problem-solvers, working across disciplines on both curiosity-driven and applied research.



01 RESEARCH

The Vector Institute has created a community of premier AI talent by attracting and retaining top machine learning and deep learning researchers. We have grown our research community from eight founding Faculty Members in 2017 to a diverse group of over 500 researchers representing well over 30 countries and 15 universities across Canada at the faculty, post-doctoral fellow, and graduate level. These leading researchers possess a broad range of specializations including health, sequential decision-making, generative models, and security, privacy, and fairness. As we grow our research strengths, we aim to make Vector a top 10 global centre for machine learning and deep learning research, and to continue attracting leading scientists and top students to Toronto, Ontario, and Canada more broadly.

2019-20

Research by the Numbers

501

researchers in Vector's community, including Faculty Members, Faculty Affiliates, Postgraduate Affiliates, graduate researchers and Post-Doctoral Fellows

10

new Canada CIFAR AI Chairs at Vector

8

new Faculty Members

29

new Faculty Affiliates

22

new Postgraduate Affiliates

263

papers published in global conferences and journals

81

research events and talks hosted

New Faculty Members and Faculty Affiliates

In the fall of 2019, Vector appointed eight new Faculty Members: Jakob Foerster, Animesh Garg, Chris Maddison, Sheila McIlraith, Gennady Pekhimenko, Toniann Pitassi, and Angela Schoellig from the University of Toronto, and Yaoliang Yu from the University of Waterloo.

Canada CIFAR AI Chairs

Part of the \$125 million Pan-Canadian AI Strategy, Canada CIFAR AI Chairs form the research backbone of a robust AI ecosystem that helps maintain Canada's leadership role in the development and application of machine learning. They are reviewed by an International Scientific Advisory Committee made up of scientific leaders from top institutions and companies.

In 2019-20, 10 Vector Faculty Members were granted Canada CIFAR AI Chairs, joining the 20 Vector Faculty Members who had previously been named.

2019-20

- Shai Ben-David, University of Waterloo
- Jakob Foerster, University of Toronto Scarborough (Starting January 2021)
- Animesh Garg, University of Toronto
- Anna Goldenberg, Hospital for Sick Children
- Chris Maddison, University of Toronto
- Sheila McIlraith, University of Toronto
- Gennady Pekhimenko, University of Toronto
- Toniann Pitassi, University of Toronto
- Angela Schoellig, University of Toronto
- Yaoliang Yu, University of Waterloo

Previously Announced CCAI Chairs

- Alán Aspuru-Guzik, University of Toronto
- Jimmy Ba, University of Toronto
- Murat A. Erdogdu, University of Toronto
- Juan Felipe Carrasquilla, Vector Institute
- Amir-massoud Farahmand, Vector Institute
- Sanja Fidler, University of Toronto
- David Fleet, University of Toronto Scarborough
- Marzyeh Ghassemi, University of Toronto
- Roger Grosse, University of Toronto
- Alireza Makhzani, Vector Institute
- Quaid Morris¹, University of Toronto
- Sara Mostafavi, University of British Columbia
- Sageev Oore, Dalhousie University
- Nicolas Papernot, University of Toronto
- Pascal Poupart, University of Waterloo
- Daniel Roy, University of Toronto
- Frank Rudzicz, Li Ka Shing Knowledge Institute, St Michael's Hospital, University Health Network
- Leonid Sigal, University of British Columbia
- Graham Taylor, University of Guelph
- Bo Wang, Peter Munk Cardiac Centre, University Health Network





Distinguished Speakers

At events throughout the year, Vector hosted a number of distinguished speakers including William Freeman (MIT), Jamie Kiros (Google Brain), and Richard Sutton (Amii, University of Alberta). As part of the Machine Learning Advances and Applications Seminars co-hosted with the Fields Institute, Vector also welcomed leading AI researchers and practitioners such as Sergey Levine (UC Berkeley), Dan Jurafsky (Stanford), Stefanie Jegelka (MIT), and more.

Recordings of many Vector programs and talks featuring the latest research from Vector scientists, as well as AI career events for students are available on [Vector's YouTube channel](#).

Research Achievement and Award Highlights [↗]

Vector Faculty Members

Alán Aspuru-Guzik, University of Toronto

- CIFAR Bio Inspired Solar Energy Lebovic Fellow
- Creative Destruction Lab Ideas Award

Juan Felipe Carrasquilla, Vector Institute

- Google Quantum Research Award 2019

David Duvenaud, University of Toronto

- Google Faculty Award 2019

Sanja Fidler, University of Toronto

- Connaught New Researcher Award

Animesh Garg, University of Toronto

- Best Conference Paper award at IEEE ICRA 2019
- Best Paper Award, Robot Learning Workshop, NeurIPS 2019

Sheila McIlraith, University of Toronto

- Fellow of the Association of Computing Machinery 2019

Frank Rudzicz, Li Ka Shing Knowledge Institute, St Michael's Hospital, University Health Network

- Best Paper award at eTELEMED 2020

Bo Wang, Peter Munk Cardiac Centre, University Health Network

- PMCC Innovation Award 2019

Richard Zemel, University of Toronto

- Best Paper Award at CoRL 2019

Amir-massoud Farahmand, Vector Institute

- International Conference on Machine Learning (ICML), Top 5% Reviewer Award, 2019
- Neural Information Processing Systems (NeurIPS), Best Reviewers Award, 2019

Angela Schoellig, University of Toronto

- First Place in the AutoDrive Challenge, SAE International
- RSS Early Career Spotlight Award, Robotics: Science and Systems (RSS) Foundation
- Best Paper Award, Robot Vision Conference on Computer and Robot Vision (CRV)
- Best Poster Presentation Award, Conference on Computer and Robot Vision (CRV)

Jimmy Ba, University of Toronto

- AI2000 Most Influential Scholar

Marzyeh Ghassemi, University of Toronto

- Canada Research Chair in Machine Learning for Health Natural Sciences and Engineering Research Council (NSERC)

Murat A. Erdogdu, University of Toronto

- Connaught New Researcher Award

Quaid Morris, University of Toronto

- Highly Cited Researcher, Clarivate Analytics

Raquel Urtasun², University of Toronto

- Creative Destruction Lab Ideas Award

². On Leave

2019-20

Research Achievement and Award Highlights⁷



Vector Faculty Affiliates

Timothy Barfoot, University of Toronto

- Best Paper Award at HEART 2019

Vaughn Betz, University of Toronto

- Google Faculty Research Award 2019

Michael Brown, York University

- Best Paper Award at CIC27 2019

Graeme Hirst, University of Toronto

- Fellow of the Association of Computational Linguistics 2019

Kyros Kutulakos, University of Toronto

- Best Paper Award at CVPR 2019

Jeffrey S. Rosenthal, University of Toronto

- Best Paper Award, Canadian Journal of Statistics 2019

Scott Sanner, University of Toronto

- Google Faculty Research Award 2019

Yu Sun, University of Toronto

- Connaught Innovation Award 2019

Grace Y. Yi, Western University

- Canada Research Chair in Data Science 2019

Significant Conferences

Vector was well-represented at four of the world's top machine learning conferences in 2019-20, publishing 61 papers and presenting 16 oral presentations and spotlights including:

International Conference on Machine Learning (ICML)

- Nine papers
- Nine orals

Conference on Computer Vision and Pattern Recognition (CVPR)

- 17 papers
- Four orals

International Conference on Learning Representations (ICLR)

- 14 papers
- One oral

Neural Information Processing Systems (NeurIPS)

- 21 papers
- Two spotlights



Celebrating Geoffrey Hinton[↗]

In October 2019, Vector hosted the Evolution of Deep Learning Symposium celebrating Geoffrey Hinton's leadership and foresight in the field and his receipt of the 2018 ACM A.M. Turing Award, generally recognized as the highest distinction for computer scientists, with Yoshua Bengio (Université de Montréal, Mila) and Yann LeCun (New York University, Facebook). The event featured talks by colleagues, collaborators, and some of Hinton's most renowned former students, including Radford Neal, Terry Sejnowski, and Ilya Sutskever.

*Chief Scientific Advisor, Vector Institute
VP and Engineering Fellow, Google
Professor Emeritus, University of Toronto*

In 2019, Hinton was also honoured with the 2019 Honda Prize, which is awarded to people generating the new eco-technology knowledge that will drive the next generation of research. The prize is a recognition that AI is expected to play an important role not only in the advancement of science and technology but also in resolving many different global issues that humankind must address in the areas of energy and climate change.



Rising Talent [↗]

Shalmali Joshi is a Postdoctoral Fellow at the Vector Institute. She received her PhD from the University of Texas at Austin in 2018, where she was advised by Schlumberger Centennial Chair Professor of Electrical and Computer Engineering, Joydeep Ghosh. Joshi's research goal is to make machine learning more reliable for clinical health care. She uses principles of probabilistic modeling, causal inference, and algorithmic fairness to inform generalization, explainability, and equity of machine learning in health. Passionate about improving transparency and accountability in machine learning, and ensuring its benefits are equitable in clinical practice, Joshi has contributed several talks and commentaries on these topics for researchers and practitioners interested in applying machine learning in health. She is the founding co-chair of the first-ever [Fair ML for Health](#) workshop at NeurIPS 2019.

Spotlight on Research⁷

Vector researchers continue to push the boundaries of machine learning and deep learning. Here are examples of Vector Faculty Members leading work in the five key research areas identified in Vector's Three-Year Strategy.

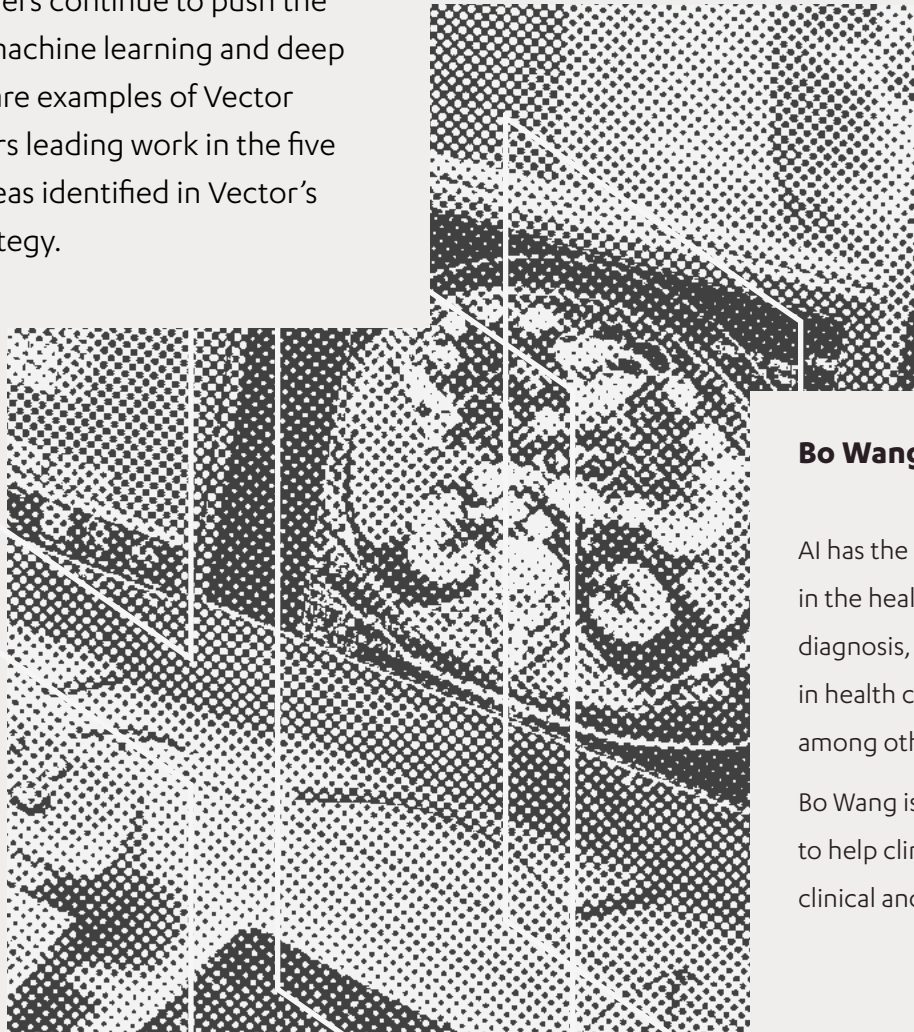
Health:



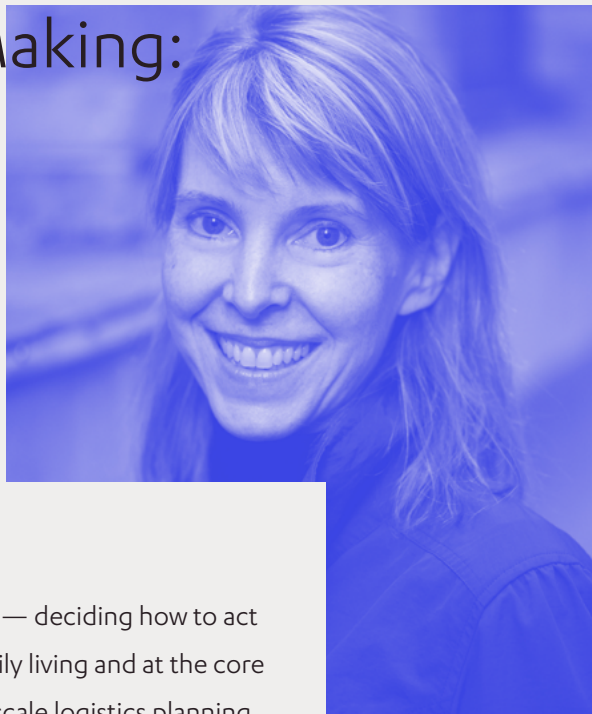
Bo Wang

AI has the potential to make an enormous impact in the health domain through improved disease diagnosis, enhanced patient care and efficiency in health care systems, and new drug discovery, among other possibilities.

Bo Wang is developing machine learning algorithms to help clinicians tailor patients' care to their unique clinical and genomic traits.



Sequential Decision Making:

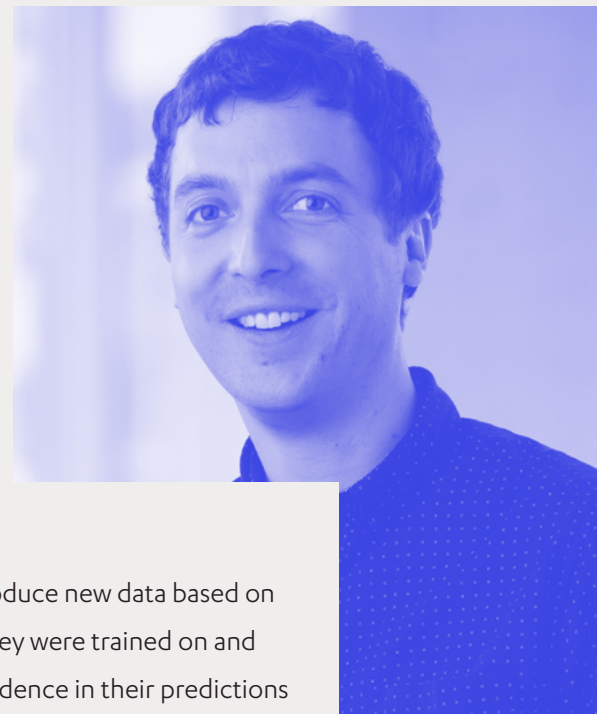


Sheila McIlraith

Sequential decision making — deciding how to act over time — is central to daily living and at the core of intelligence. From large-scale logistics planning to in-home robots, advances in this area will support humans in making decisions that improve their day-to-day lives.

Sheila McIlraith's research explores knowledge representation and automated reasoning in sequential decision making, and is helping to develop human-aware AI and make human-machine interaction more seamless, among other applications.

Generative Models:



Graham Taylor

Generative models can produce new data based on the original dataset that they were trained on and estimate appropriate confidence in their predictions like aiding object recognition and tracking. Potential applications include creating new text and images and making predictions with a given level of accuracy.

Graham Taylor is exploring applications of generative models, including iterative image generation and construction of physical assemblies, starting with the children's toy LEGO. His work with Facebook AI Research (FAIR) investigates ways to quantitatively evaluate their outputs in a way that captures quality, diversity, and consistency with the instructions they are given.

Understanding Machine Learning and AI:

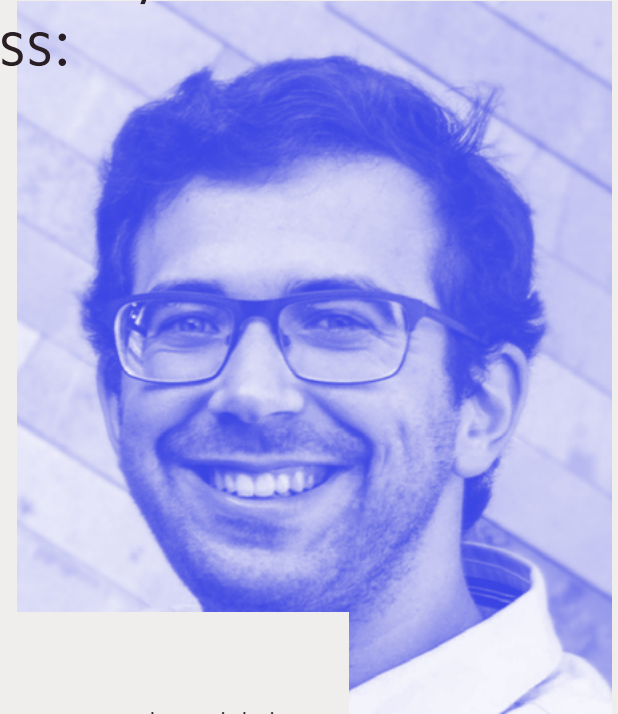


Angela Schoellig

AI and machine learning techniques — particularly deep learning methods — are being widely deployed. As algorithms become embedded in real-world applications, it is important to have characterizations of situations in which they will perform well and those in which they will not.

Angela Schoellig conducts research at the interface of robotics, controls, and machine learning with a goal to enhance the performance, safety, and autonomy of robots by enabling them to learn from both past experiments and from each other.

Security, Privacy, and Fairness:



Nicolas Papernot

Security and privacy of AI systems are salient global issues. The costs of security breaches are immense, and potential leakage of private data is top-of-mind.

Nicolas Papernot's research interests bring machine learning to bear on issues of security and privacy. He seeks to design machine learning algorithms that responsibly train models on private data.

2019-20

Industry Programs by the Numbers

926

participants in Vector
industry programs and
courses

6

collaborative projects
underway with two
completed during the
fiscal year

255

collaborative project
participants from sponsor
companies

25

companies participating
in projects

3

Business Insights Series
sessions (formerly known
as AI for Executives)

6

Endless Summer School
sessions

20

Face-to-Face meetings

3

Certificate Courses

19

AI workshops for startups,
SMEs, and the public

9

commercialization
education sessions for
Vector researchers

02 AI FOR INDUSTRY

Vector has expanded and refined a suite of programs, courses, and projects to help businesses raise their AI fluency, understand its commercial value, and acquire the skills, frameworks, and talent base necessary to compete and innovate using the technology. Our programs, led by top Vector Institute researchers and practitioners, enable technical teams to build fundamental and advanced skills. Programs also deliver key business insights to executives and non-technical professionals. As a complete suite, these programs help organizations across sectors and various levels of AI adoption develop the proficiency required to execute projects as part of a larger AI strategy.

Programs and Courses for Industry

Sponsors

- The **Endless Summer School** program offered seminars covering important recent technical advances. Topics this year included natural language processing, computer vision, advances in machine learning theory, AI and Cancer Research, and reinforcement learning.
- The **Business Insights Series** continued to provide non-technical professionals with frameworks for understanding AI opportunities, implementation, and scale. Topics included Introduction to AI and Workforce Development: Building AI Capacity Inside Your Organization.
- The **Face-to-Face** program enabled industry sponsors to participate in individual meetings with Vector researchers, receiving advice and feedback on highly-specific AI challenges.
- The preliminary offering of **Certificate Courses** featured instruction on AI foundations and deep learning by Vector researchers Juan Felipe Carrasquilla, Jorn Jacobson, Alireza Makhzani, and Graham Taylor.
- Finally, Vector held a series of **networking events** that brought industry sponsors' leadership teams together with leaders in

business applications of AI. Guest speakers included Chris Meserole (Deputy Director, Brookings AI & Emerging Tech Initiative), Eric Schmidt (then Technical Advisor at Alphabet Inc. and former CEO and Executive Chairman at Google), and Ruth Porat (Chief Financial Officer CFO of Alphabet Inc. and Google).

Collaborative Projects

Vector led several projects in which large groups of technical professionals from sponsor companies came together with the guidance of Vector researchers and practitioners. Through these collaborations, participants gained hands-on experience with AI techniques and concepts that informed their respective product development, risk management, and application processes.

Projects included:

- Applying reinforcement learning to reduce energy costs and carbon emissions.
- Two knowledge transfer projects focused on Natural Language Processing (NLP). Participants, including 37 industry sponsor participants from 16 different companies and 23 Vector researchers and staff, replicated a state-of-the-art NLP model and fine-tuned it to automate speech and text

processing in areas such as health, law, and finance.

- Two projects with the financial services sector covering new methodologies and algorithms to make banking more secure, build a shared vision of responsible AI adoption, and explore options to manage the technical issues in machine learning such as model robustness, risk, fairness, and interpretability.
- A project focused on entity resolution where machine learning was used to identify and consolidate records in a data set referring to the same entity (such as proper name variations) across different data sources.



VECTOR INSTITUTE INDUSTRY SPONSORS⁷

PLATINUM

founding

- Accenture
- BMO Financial Group
- Google
- Loblaw Companies Ltd.
- NVIDIA
- RBC
- Scotiabank
- Shopify Inc.
- TD Bank Group
- Thomson Reuters
- Uber

GOLD

founding

- Air Canada
- CIBC
- CN
- Deloitte
- EY
- Georgian Partners
- Intact Financial Corporation
- KPMG
- Magna International
- Manulife
- PwC Canada
- Sun Life Financial
- TELUS
- Thales

SILVER

founding

- EllisDon Corporation
- Linamar Corporation

BRONZE

founding

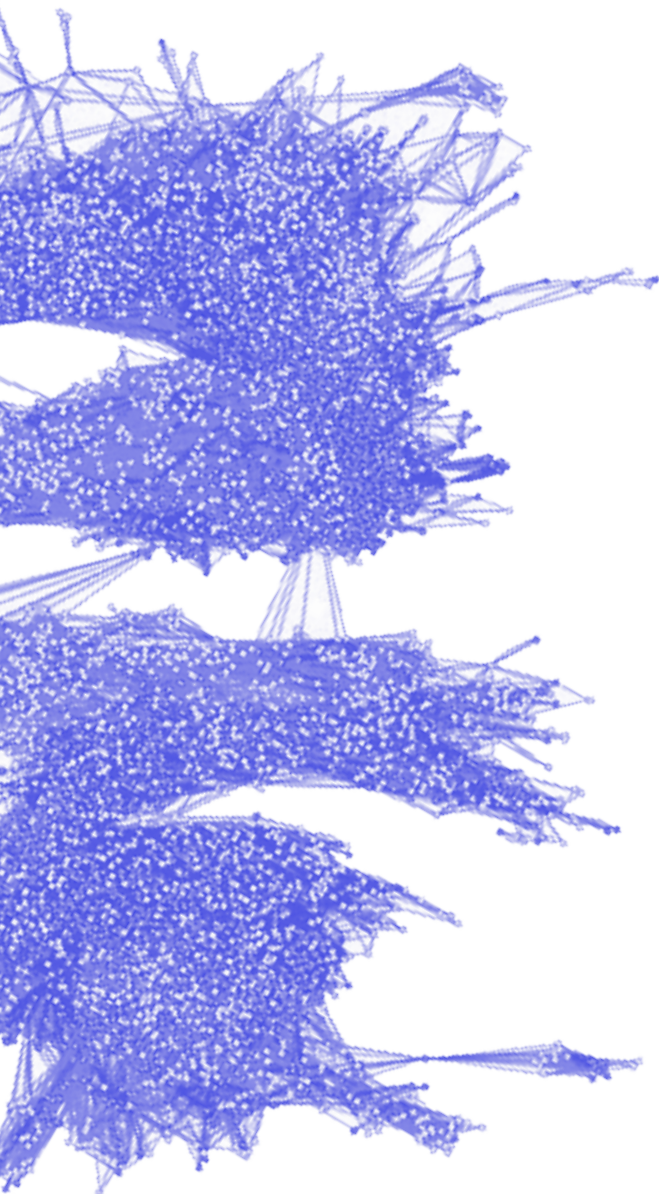
- Clearpath
- Deep Genomics
- Dessa
- FreshBooks
- integrate.ai
- Layer 6
- North
- ROSS Intelligence
- Wattpad

2018

- MindBridge Analytics Inc.
- Stradigi AI
- tealbook
- Wysdom AI

2019

- Ada
- BenchSci
- Canvass Analytics Inc.
- Darwin AI
- GoldSpot Discoveries Inc.
- League
- Surgical Safety Technologies



AI Workshops for Startups, SMEs, and the Public

In addition to programs designed to give a competitive advantage to the industry sponsors that made the founding of the Vector Institute possible in 2017, the Vector Institute partnered with Ontario Centres of Excellence, MaRS, and Communitech to offer 19 workshops. Sessions detailed key concepts, techniques, and terminology in a manner tailored for the public, startups, and SMEs including:

- Introduction to AI: What it is, what it isn't, and where should it be used?
- Introduction to Trustworthy AI: Avoid common errors and misconceptions on AI that may undermine trust in your models
- Model Robustness and AI: Understand how to manage model robustness for AI-enabled solutions
- Fairness and AI: Explore the connection between AI and Fairness and how to avoid common pitfalls
- Interpretability and AI: Navigate the relation between Explainable Models and AI, their trade-offs, and related risks
- Model Risk and AI: Discussion on how to address Model Risk when implementing AI technologies

Commercialization Sessions

Commercialization education sessions gave Vector researchers a chance to connect with and hear from experienced industry specialists on a range of topics, including venture capital, contract law, intellectual property and AI, patent eligibility, and entrepreneurship. These sessions featured presentations from Jordan Jacobs (Radical Ventures), Prashant Matta (Panache Ventures), Madalin Mihailescu (Georgian Partners), Filip Boskovic and Benjamin Mak (Ridout & Maybee LLP), and Stephen Piron (Dessa).

2019-20

Talent and Workforce Development by the Numbers

1,000

AI master's students, including 815 enrolled in Vector-recognized programs and 315 in individual AI-related study paths as of March 31, 2020

800

students participated in career events

25

companies participated in career events to meet and recruit students

22

Vector-recognized AI programs recognized in Ontario, including seven added in 2019-20

76

students awarded scholarships in 2019-20

435

candidate profiles with AI skills on Digital Talent Hub

223

AI-related job postings by 35 employers

03 TALENT AND WORKFORCE DEVELOPMENT

With support from the Province of Ontario, Vector continued to expand Ontario's workforce-ready AI talent pool by working with post-secondary institutions across Ontario to develop master's programs in core technical and complementary areas such as business and health. These programs respond directly to employers' needs, retaining and attracting top students with competitive scholarships.

Ontario universities have responded quickly to employers' increased demands for AI talent. In the last two years, Vector's committee of industry representatives and faculty has recognized [22 AI-master's programs at 11 universities](#) across Ontario for training graduates with the skills and competencies highly sought by industry. Of these programs, four are brand new degree programs and 12 are programs whose curricula have been updated

03 TALENT AND WORKFORCE DEVELOPMENT

to offer AI-specific minors, concentrations, and courses.

These programs are contributing to an increase in workforce-ready AI candidates who in turn participate in Vector-led programs for connecting graduates and alumni into the Ontario economy. As of March 31, 2020 there were more than 815 master's students enrolled in recognized programs and a further 315 students in individual AI-related study paths.³

AI Master's Programs Recognized by the Vector Institute in 2019-20

Ontario Tech University

- Master of Information Technology Security—AI specialization

Lakehead University

- MSc in Computer Science (AI)

University of Windsor

- MSc in Computer Science (AI)

University of Ottawa

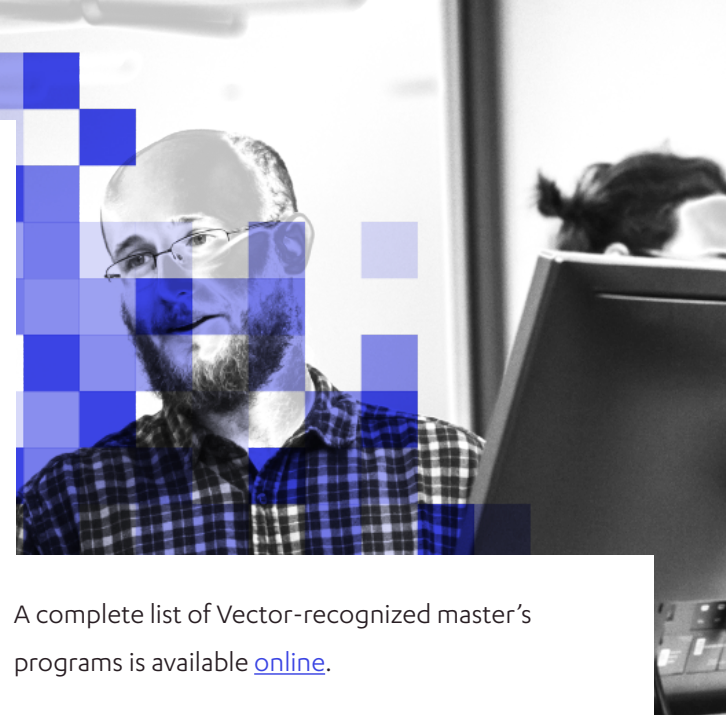
- Master of Applied Science in Electrical and Computer Engineering
- M.Eng in Electrical and Computer Engineering – Applied Artificial Intelligence Concentration

Queen's University

- Master of Management Analytics; Global Master of Management Analytics
- Master of Applied Science, Electrical and Computer Engineering in AI

University of Toronto

- MSc in Health Policy, Management and Evaluation, Emphasis in Health Systems AI



A complete list of Vector-recognized master's programs is available [online](#).

3. As of March 31 2019, there were over 200 students enrolled in Vector-recognized master's programs and 192 students in individual AI-related study paths.

Vector Scholarships in Artificial Intelligence

The Vector Scholarship in Artificial Intelligence, valued at \$17,500, helps to attract the best and brightest students to AI-related master's programs in Ontario. These merit-based entrance awards recognize exceptional candidates pursuing a master's program recognized by the Vector Institute or who are following an individualized study path that is demonstrably AI-focused. A highly competitive award, 76 scholarship recipients were announced in 2019-20.

This year's scholarship recipients included students from the following institutions and programs:

Carleton University

- Computer Science
- Economics

University of Guelph

- Computer Science (Collaborative Specialization in AI)*
- Engineering (Collaborative Specialization in AI)*

Lakehead University

- Computer Science*

McMaster University

- Computational Science & Engineering
- Electrical & Computer Engineering

University of Ottawa

- Computer Science*

Queen's University

- Computer Science*
- Electrical & Computer Engineering*
- Management in Artificial Intelligence (Smiths School of Business)*

Ryerson University

- Data Science and Analytics*

University of Toronto

- Aerospace Science & Engineering
- Applied Computing
- Biomedical Engineering
- Computer Science
- Health Informatics*
- Management Analytics (Rotman School of Management)*
- Mechanical & Industrial Engineering

University of Waterloo

- Computer Science
- Data Science*
- Electrical and Computer Engineering
- Systems Design

Western University

- Collaborative Specialization in AI*
- Data Analytics*

York University

- Business Analytics (Schulich School of Business)*
- Computer Science*

*Vector-recognized AI master's programs

Connecting Talent and Employers

The Vector Institute is facilitating connections between its community of AI talent and industry sponsors through career-focused events, a new Digital Talent Hub, and student outreach. More than 90 Vector community members, including alumni of Vector-recognized programs, researchers, and scholarship recipients, have found employment with Vector's industry sponsors.

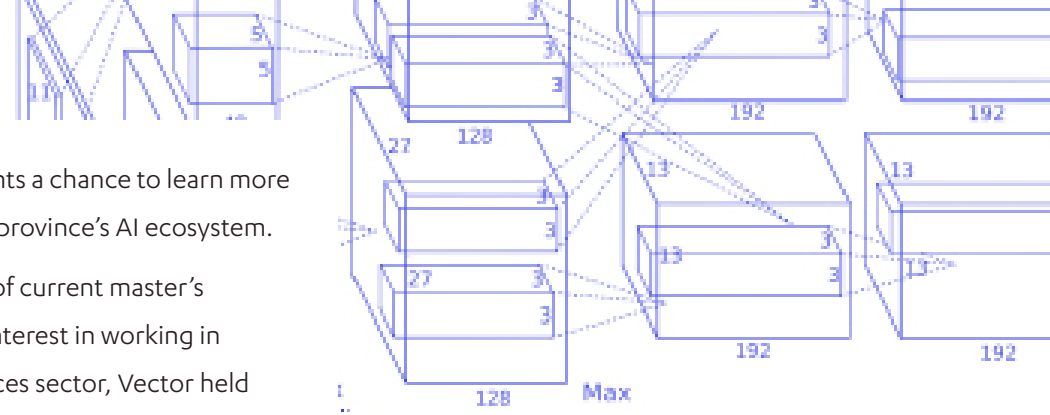
- To support networking and recruitment, Vector's inaugural **AI Master's Summit and Career Fair** attracted 300 students from more than 10 universities across Ontario who each had the opportunity to connect with 18 industry sponsors from a range of sectors.
- **The Careers in AI event series** launched in 2019 with two local events that engaged more than 100 master's students in the Kitchener-Waterloo and Ottawa areas. These events connected students and researchers from different institutions with AI practitioners in companies like Shopify, Deloitte, Sun Life Financial, and MindBridge Analytics Inc. Vector also provided career consultations for these students, allowing

Ontario master's students a chance to learn more about the depth of the province's AI ecosystem.

- Given that 46 per cent of current master's students indicated an interest in working in Canada's financial services sector, Vector held its first sector-specific career event in January 2020. More than 130 students from 12 Ontario universities attended the **Research and Careers in AI: Financial Services Edition**, which featured the presentation of research and AI use cases by six industry sponsors: BMO, RBC, Scotiabank, TD Bank Group, CIBC, and Manulife.

Digital Talent Hub

[Vector's Digital Talent Hub](#) was launched in December 2019 to connect Vector's community of students, researchers and alumni with internship and full-time public and private sector opportunities, creating a large pool of vetted, career-ready AI candidates. As of March 2020, 435 job-seekers had created profiles on the Hub and 35 employers had posted 223 AI-related roles. Early feedback from employers indicates that Vector has improved their ability to hire AI talent and led to successful placements.



Rising Talent⁷



MARAL RASOOLIJABERI

Vector Scholarship in AI Recipient (2019-20)

Master's of Applied Science in Systems Design
Engineering, University of Waterloo

"I greatly appreciate the Vector Institute for this scholarship, as the impact on my student life was significant, allowing me to focus on my research and studies during the first year of my master's degree. I am so thankful to be invited to be part of the Vector community, where I can network with other students and learn from industry."

Maral Rasoolijaberi graduated from Amirkabir University of Technology (Tehran Polytechnic) in Iran, where she completed her BSc in Electrical, Electronics, and Communication Engineering. Her undergraduate research inspired her to learn more about biomedical applications in AI, leading her to pursue a master's degree at the University of Waterloo focused on improving the accuracy of image search in large archives of histopathology images. Her project will help pathologists match current and past cancer patient biopsies, allowing them to learn from past cases, and provide better and more precise care for their patients. Recently, her work on histopathology images was published at the 2020 International Joint Conference on Neural Networks. Her professional goal is a career in health care research and development.

04 HEALTH



The diverse, population-wide data in Ontario's large, single-payer health system present a significant opportunity to apply AI to improve health research, systems, and care. Working with partners in the health and academic sectors over the past year, Vector has built on its founding health strategy in pursuit of specific objectives in its new Three-Year Strategy to enable effective and appropriate research access to health data in support of whole-life health for Ontarians and all Canadians.

Health Data Access & Analysis

Realizing the potential of AI to improve patient care and reduce health service delivery costs begins with data. Vector has made significant strides in facilitating improved access to health data, and in defining modern health data governance frameworks to provide researchers with secure access to health data while upholding patient privacy.

MODERN HEALTH-DATA GOVERNANCE FRAMEWORK

The Vector Institute and the Canadian Institute for Health Information (CIHI) met with health data stakeholders including Institute for Clinical

Evaluative Sciences (ICES), HPC4Health (a joint initiative of The Hospital for Sick Children and University Health Network), Sunnybrook Research Institute, MaRS, Population Data BC, Compute Ontario, and the Global Alliance for Genomics and Health to pool local and international experiences and identify essential elements for a modern health data governance framework. This discussion played an important role in building consensus around responsible health data governance, paving the way for work in this area planned in Vector's Three-Year Strategy. Key requirements and considerations were published in [The Globe and Mail](#) and subsequently in [the International Journal of Population Data Science](#).

GENERAL MEDICINE INPATIENT INITIATIVE (GEMINI)

Led out of Unity Health Toronto's St. Michael's Hospital, GEMINI is a unique, big-data platform providing advanced methods to extract and standardize data captured in electronic health records from seven hospitals across Ontario. As the initiative expands to include more hospitals in the province, Vector and Unity Health are leveraging administrative, admission, discharge, transfer (ADT), lab, radiology reports, pharmacy, and clinical EMR

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data for over 350,000 patients. This initiative has expanded to include collaboration between GEMINI and Vector, enabling participating organizations and researchers to act nimbly to facilitate the development of machine learning models that will assist in responding to the COVID-19 pandemic.

HEALTH AI DATA ANALYSIS PLATFORM (HAIDAP)

Running concurrently with the GEMINI initiative, Vector, ICES and HPC4Health, with support from Compute Ontario, developed the HAIDAP. This secure, high-performance computing environment makes deidentified population-wide health data available for AI, machine learning, and other computation-intensive advanced analysis. As of March 2020, there were 16 active research projects underway in HAIDAP's advanced computing environment.

Partnerships to Improve Health Data Research

Successfully leveraging AI in the clinical environment requires cross-disciplinary collaboration. Over the past 12 months, Vector and its researchers led events and programs aimed at facilitating such partnerships and sharing best practices.

HEALTH AI ROUNDS

The Health AI Rounds lecture series brought together machine learning researchers and the health research community, drawn by invited world-class scientists and clinicians speaking on questions at the intersection of health and AI. Speakers this year included Samantha Kleinberg (Stevens Institute of Technology), Isaac Kohane (Harvard Medical School), Nigam Shah (Stanford University), and Jenna Wiens (University of Michigan).

MACHINE LEARNING FOR HEALTH (ML4H) UNCONFERENCE

With Marzyeh Ghassemi's leadership, Vector and Trillium Health Partners hosted the Machine Learning for Health (ML4H) Unconference in May 2019. Bringing together computer scientists and physicians to address the question, "What

healthcare problems should ML4H be trying to solve?" participants formed groups to work on topics ranging from "Mental Health Tools for Fast-Onset Crises" to "EHR Data Mining to Build Patient Cohorts/Phenotypes," identifying short-term objectives and long-term opportunities in the field. A paper summarizing the findings is forthcoming.

Enabling Clinical AI Deployment

Pathfinder Projects⁴ — a series of early AI deployment projects supported by Vector and led by hospitals and institutions across Ontario — have generated practical insights for addressing challenges and opportunities related to deploying AI in clinical settings. Vector has since leveraged these insights and shared best practices in order to give health practitioners access to the best-available AI knowledge and tools to improve health systems and care. For example, Vector's partnership with Unity Health to develop an early-warning system for patients requiring transfer to the ICU established the groundwork for the GEMINI collaboration that will enable researchers and health practitioners to derive valuable insights from hospital data to inform COVID-19 responses.

HEALTH AI DEPLOYMENT SYMPOSIUM

With Anna Goldenberg's leadership and in partnership with The Hospital for Sick Children (SickKids), Vector organized the Health AI Deployment Symposium to showcase examples of AI research translated into practice in health care. Speakers from the University of Michigan, Duke University, Johns Hopkins University, University

of Pennsylvania, and Kaiser Permanente shared successes, challenges, and lessons learned from their experiences. A panel of scientific leads for Vector's Pathfinder Projects presented their work on health AI implementation in Canada. The symposium attracted more than 150 participants from academia, health sector organizations, and government agencies. Insights were published in a [white paper](#).

CUSTOMIZED TRAINING SESSIONS FOR HEALTH PRACTITIONERS

In 2019, Vector researchers led customized training sessions for CIHI. These sessions brought together more than 30 data scientists and over 100 staff from CIHI offices in Toronto and Ottawa. Participants received machine learning training and guidance on AI tools, enabling them to better understand the benefits of machine learning and advance their strategic AI projects.

4. The first five Pathfinder Projects included: AI Early Warning for Patients at Risk of Needing Transfer to Intensive Care Unit; AI Tick Identification to Combat Lyme Disease; Enhancing Radiology with AI; AI-Enhanced "Medly" for Remote Monitoring of Patients with Congestive Heart Failure; and, Artemis Machine Learning for Early Diagnosis of Life-Threatening Infection in Premature Infants. Pathfinder Project partners include Ontario Tech University, University of Waterloo, McMaster Children's Hospital, Southlake Regional Health Centre, St. Michael's Hospital, University Health Network, and Public Health Ontario. Projects have been paused during the COVID-19 pandemic and are expected to resume in fall 2020.



Vector Responds to COVID-19 ⁷

As the potential scale of the COVID-19 pandemic became clear in the early months of 2020, Vector convened discussions and participated in consultations on various responses. Vector researchers sprang into action and spun up projects to explore the power of machine learning to predict contagion, therapies, economic impact, and more. By the middle of March 2020, Bo Wang and Vector students Duncan Forster and John Giorgi were already developing CiteNet, a tool that automatically indexes the pre-print servers bioRxiv and medRxiv, allowing COVID-19 researchers to quickly find the most up-to-date research.

Work by Vector researchers and their colleagues also made possible a high-resolution 3D molecular structure of the spike protein of the 2019 coronavirus, an essential step towards developing vaccines and antiviral drugs. The 3D mapping was made possible by a software package called CryoSPARC, which was built using algorithms developed by Vector researchers Ali Punjani, David Fleet, and colleagues.

Nearing the end of the 2019-20 fiscal year, Vector researchers were laying the groundwork for 25 projects to develop AI-enabled responses to the pandemic.

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BRIDGING AI WITH SOCIETAL & ECONOMIC IMPACT



Vector's community includes industry and scientific leaders, noted economists and entrepreneurs, prominent health care stakeholders, with unique and informed perspectives on important questions related to fairness, explainability, safety, misinformation, regulations and standards, ethics, privacy, and economic competitiveness.

Throughout 2019-20, Vector convened and participated in interdisciplinary dialogues at the intersections of AI research and important societal and economic considerations. It is our goal to convene this community to actively share and contribute expertise and insights on policy issues related to AI adoption that supports the best interests of Ontarians and Canadians.

Launch Symposium for the Schwartz Reisman Institute for Technology and Society

In June 2019, the University of Toronto marked the [launch](#) of the Schwartz Reisman Institute for Technology and Society with a symposium focused on interdisciplinary research into the role of AI and other technologies. Vector

researchers participated in panel discussions on fairness and the future of technology and society. Later in the year, Vector researchers Gillian Hadfield, Sheila McIlraith, and Toniann Pitassi were announced as members of the inaugural research leadership team. Vector will co-locate with the Institute in the Schwartz Reisman Innovation Centre upon completion of its construction, enabling many more opportunities for interdisciplinary research in AI and related societal challenges and opportunities.

Responsible AI Event

In August 2019, the Vector Institute and the Schwartz Reisman Institute for Technology and Society invited researchers from across disciplines and industry sponsors to co-host Chris Meserole of the Brookings Institute for an event exploring issues at the intersection of AI and society.

In his presentation, Chris Meserole sketched a blueprint for overcoming disciplinary silos in order to combine technical research in machine learning with explorations of the ethical, legal, and social implications of AI. The event also featured [presentations](#) from leading researchers and practitioners on topics such as decision-making

systems, differential privacy, AI safety, AI tools in clinical care, explainability, and standards.

Task Force on Artificial Intelligence and Emerging Digital Technologies

The Royal College of Physicians and Surgeons of Canada commissioned a task force to prepare Canada's medical profession for the ways that AI will change medical training and health care delivery. Former Vector Institute Vice-President, Health Strategy and Partnerships Alison Paprica and Frank Rudzicz joined the Task Force to assist its research into the potential of AI technologies and to inform its recommendations to the Royal College. In February 2020, the Royal College published the ["Task Force Report on Artificial Intelligence and Emerging Digital Technologies,"](#) with more than a dozen findings and recommendations to guide the responsible application of AI in Canadian health care.

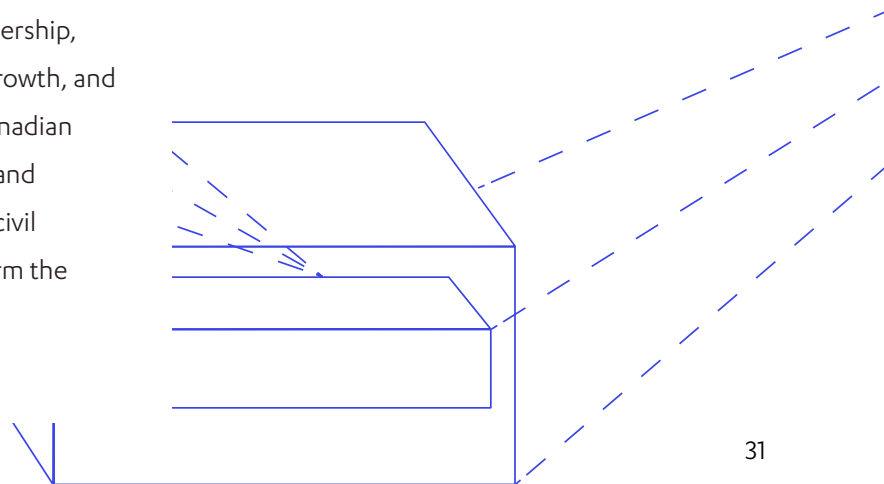
Task Force on Artificial Intelligence for Health (AI4Health)

In September 2019, CIFAR convened a task force to make recommendations for a national strategy on AI for health. The goal is to leverage Canada's AI

research ecosystem, and its extensive population-wide data holdings within the publicly funded health system, to make Canada a world-leader in the development and adoption of AI-based approaches to health care. The task force comprised 17 leaders with diverse expertise, including Vector founders, faculty, and executives. After engaging with a wide array of stakeholders across sectors and across the country, the task force developed and published [a set of key recommendations](#), including how the responsible use of AI for health can deliver benefits to Canadians.

Government of Canada Advisory Council on Artificial Intelligence

In May 2019, the Minister of Innovation, Science and Economic Development, announced the creation of [the Advisory Council on Artificial Intelligence](#) to advise the Government of Canada on building the country's AI strengths and global leadership, identifying opportunities for economic growth, and ensuring that AI advancements reflect Canadian values. The Vector Institute joined CIFAR and other AI leaders from Canadian industry, civil society, academia, and government to form the Advisory Council.



06 Operations

Vector's space, purpose-built for collaboration and machine learning research, provides its community with access to high-performance computing equipment and brings together researchers from across institutions.

largest concentration of student- and researcher-led startups. Each year, the centre will host researchers, investors, industry collaborators, and international visitors.

High-Performance Computing

In 2020, Vector acquired 240 NVIDIA Quadro RTX 6000 Graphics Processing Units (GPUs) to expand its computing infrastructure but instead redirected this capacity for use in Ontario's Health Data Platform to enable data-intensive analysis and inform public health decision-making in response to the COVID-19 pandemic.

Breaking Ground on Our New Home

In November 2019, Vector Institute President and CEO Garth Gibson joined philanthropists and business leaders Gerald Schwartz and Heather Reisman, University of Toronto President Meric Gertler, and other university leaders to break ground on the Schwartz Reisman Innovation Centre.

The 750,000-square-foot complex will serve as a new home for Vector, locating it alongside the Schwartz Reisman Institute for Technology and Society, a host of biomedical innovation experts, and the country's

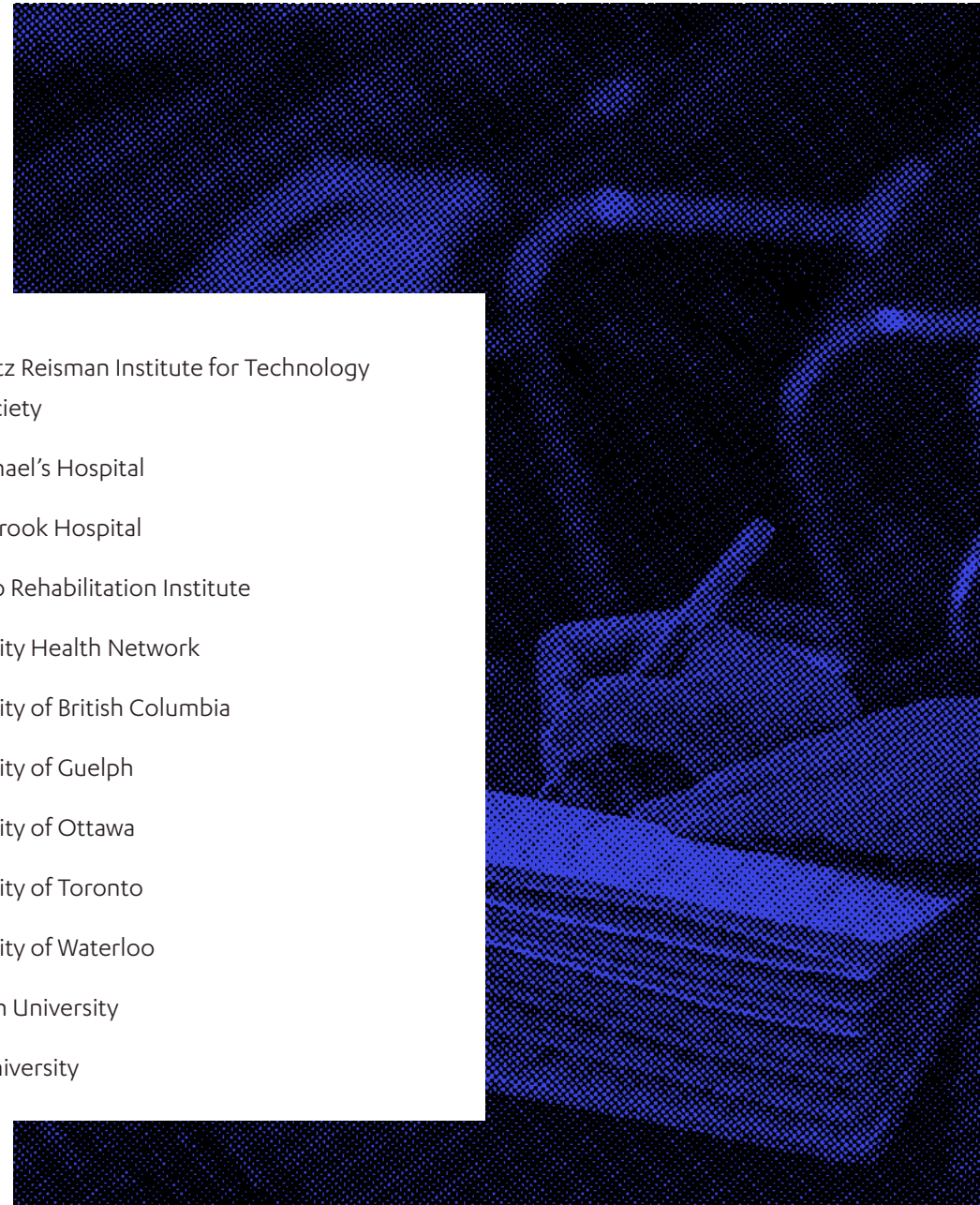


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Teeple Architect

Affiliated Institutions

The Vector Institute, including its Faculty Members, Faculty Affiliates, Postgraduate Affiliates, graduate researchers, and Post-Doctoral Fellows, represents and collaborates with a wide range of institutions across Canada.

- Carleton University
- Compute Ontario
- Dalhousie University
- Fields Institute
- Holland Bloorview Kids Rehabilitation Hospital
- Hospital for Sick Children (SickKids)
- McMaster University
- Ontario Institute for Cancer Research
- Ontario Tech University
- Perimeter Institute for Theoretical Physics
- Princess Margaret Cancer Centre
- Queen's University
- Ryerson University
- Schwartz Reisman Institute for Technology and Society
- St. Michael's Hospital
- Sunnybrook Hospital
- Toronto Rehabilitation Institute
- University Health Network
- University of British Columbia
- University of Guelph
- University of Ottawa
- University of Toronto
- University of Waterloo
- Western University
- York University



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Financials

To view the Vector Institute's audited financial statements for the 2019-20 fiscal year, please visit <https://vectorinstitute.ai/> ⁷

The Vector Institute launched in March 2017 with combined total funding commitments of \$135 million over its first five years. These sources of funding include:

- Provincial funding through Ontario's Ministry of Economic Development, Job Creation and Trade to establish the institute, deliver core programming, and support the development of the AI ecosystem.
- Federal funding from the Canadian Institute for Advanced Research (CIFAR) to support the Canada CIFAR AI Chairs Program, graduate training, institute operations, and the participation of the Chairs and trainees in national AI activities.
- Industry sponsorships through Vector's 47 industry sponsors; 27 make up Vector's Platinum, Gold, and Silver level sponsors that provide direct funding while 20 AI-based startups and scaleups (Bronze Sponsors) play a vital role in the Ontario AI ecosystem by contributing time and expertise.

The Vector Institute received an additional \$10 million in 2018-19 through Ontario's Ministry of Economic Development, Job Creation and Trade to grow the province's AI workforce by working with

post-secondary institutions to enhance, expand, and create new AI master's programs, draw top talent to those programs, and connect students and alumni to internship and career opportunities in Ontario.

Vector's financial support was front-end loaded, and Vector began the 2017-18 fiscal year with \$30 million from the Province of Ontario. By the end of the 2018-19 fiscal year, the full provincial commitment of \$60 million (including \$10 million to expand the number of Ontario AI master's graduates) had been received.

The way in which Vector's funding was front-end loaded by its government partners means that cash reserves will be used in subsequent fiscal years to support normal business expenses in compliance with transfer payment agreements and the objectives described in Vector's Three-year Strategy.

Statement of Financial Position

March 31	2020	2019
Assets		
Current		
Cash and cash equivalents (Note 1)	\$ 29,080,279	\$ 59,919,382
Short-term investments (Note 1)	28,000,614	—
Accounts receivable	2,328,888	3,545,872
Current portion of employee loans (Note 2)	279,306	194,443
HST rebate receivable	48,681	109,887
Prepaid expenses	283,011	53,240
	60,020,779	63,822,824
Employee loans (Note 2)	1,426,573	1,163,666
Capital assets (Note 3)	6,169,573	5,897,982
	\$ 67,616,925	\$ 70,884,472
Liabilities and Net Assets		
Current		
Accounts payable and accrued liabilities	\$ 3,596,301	\$ 3,529,682
Deferred rent	941,542	1,209,424
Deferred contributions (Note 4)	28,667,883	41,137,062
Deferred capital contributions (Note 5)	5,310,165	4,751,919
	38,515,891	\$ 50,628,087
Net Assets		
Unrestricted net assets	29,101,034	20,256,385
	\$ 67,616,925	\$ 70,884,472

To view Vector Institute's audited financial statements for the 2019-2020 fiscal year, please visit <https://vectorinstitute.ai/>

Statement of Operations

For the year ended March 31	2020	2019
Revenue		
Government grants		
Province of Ontario	\$ 10,276,610	\$ 9,158,460
Federal Government	5,535,881	5,817,138
Industry partners	8,708,307	12,520,983
Amortization of deferred capital contributions	1,747,992	1,390,606
Investment income	802,573	316,329
Fees for service	287,759	200,728
Materials acceleration project	-	125,838
	27,359,122	29,530,082
Expenses		
Research and education (Note 7)	6,577,168	5,936,770
Industry skills training (Note 7)	666,075	602,951
Technology adoption (Note 7)	3,399,754	2,324,866
Business acceleration (Note 7)	440,764	1,500,000
General and administration (Note 7)	3,635,128	3,671,656
RAISE AI	1,797,007	1,382,812
Materials acceleration project	-	125,838
Employee loans accretion expense (recovery) (Note 2)	(82,300)	121,891
Amortization	2,080,877	1,390,606
	18,514,473	17,057,390
	\$ 8,844,649	\$ 12,472,692

07 TEAM AND LEADERSHIP

As at time of publication in November 2020

Members and Board of Directors

The Vector Institute is governed by a highly accomplished volunteer Board of Directors drawn from the private sector, public sector, academic, and research communities. Vector's Members of the Corporation and Board of Directors include:

ED CLARK, CHAIR

JANET BANNISTER

CHARMAINE DEAN

JANET L. ECKER

VIVEK GOEL

CHAVIVA HOSEK

NADIR MOHAMED

MICHAEL SERBINIS

TERRENCE SULLIVAN

MELANIE WOODIN

Leadership

GARTH GIBSON

President and Chief Executive Officer

RON BODKIN

Vice President, AI Engineering and Chief Information Officer

GARY BURLAKOFF

Director, Finance

CAMERON SCHULER

Vice President, Industry Innovation and Chief Commercialization Officer

ROXANA SULTAN

Vice President, Health

ALAN VEERMAN

Chief Operations Officer

RICHARD ZEMEL

Research Director

Professional Team

From industry innovation and commercialization, to research programs, academic partnerships, health strategy, and more, Vector has put together an experienced and highly professional team to carry out its mission.



The Vector Institute is an independent, not-for-profit corporation dedicated to advancing artificial intelligence, excelling in machine learning and deep learning. Our vision is to drive excellence and leadership in Canada's knowledge, creation, and use of AI to foster economic growth and improve the lives of Canadians. The Vector Institute is funded by the Province of Ontario, the Government of Canada through the Pan-Canadian AI Strategy administered by CIFAR, and [industry sponsors](#) from across the Canadian economy.

[Read our Three-Year Strategy](#)[↗]

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