VECTOR INSTITUTE

ANNUAL REPORT 2019

APRIL '18-MARCH '19

AI is Working.

AI TALENT AND COMPANIES ARE CHOOSING TO LOCATE IN CANADA – HOME TO SOME OF NORTH AMERICA'S TOP TECH TALENT MARKETS.

- Toronto ranks as **the number three top tech talent market in North America** (measured by cost and quality) and **tops North America's "Brain Gain"** list as the largest net gainer of talent with an excess of **57,600 technology jobs** added over technology degrees granted in the last five years.[1]
- Toronto has the **fastest growing technology labour pool in North America**, increasing by 54 per cent in 2018.[2]
- Montreal, Ottawa, Toronto, and Vancouver provide the **best value in North America** when cost and quality of talent are compared.[3]
- Hamilton, Waterloo Region, Quebec City, Winnipeg, and Calgary are all on the CBRE's list of the next **25 up-and-coming tech talent markets**.[4]
- In Canada, AI venture capital funding has increased for two consecutive years, with companies raising $548 million in 2018, a 51 per cent increase year-over-year.[5]
- According to *The Economist,* Toronto is among "tomorrow's innovation hotspots," cities with the greatest potential to challenge the leadership of innovation powerhouses.[6]

CANADA'S "BRAIN GAIN" AND "BRAIN RETAIN" TRENDS ARE RESULTING IN A RAPIDLY EXPANDING POOL OF AI TALENT LOCALLY, MEANING COMPANIES CAN HIRE WITHIN.

- Within the two years since Vector's launch, over **$1 billion in AI and technology investments have been announced in Canada**, which will result in the creation of **25,000 jobs**.[7]

THE PAN-CANADIAN AI STRATEGY IS DELIVERING ON ITS GOAL TO PRODUCE MORE TOP TALENT BY ATTRACTING WORLD-CLASS AI RESEARCHERS TO CANADA.

- There are now **over 600 AI researchers** across the three institutes supported by the Pan-Canadian AI Strategy – Vector Institute, Amii, and Mila – including graduate researchers and faculty.[8]

THE VECTOR INSTITUTE PRODUCES NOT JUST TOP RESEARCHERS BUT SUPPORTS TRAINING OF ADDITIONAL MASTER'S STUDENTS THAT CAN BE PLACED DIRECTLY INTO ONTARIO-BASED COMPANIES, SUPPORTING A HIGHLY-SKILLED WORKFORCE THAT MEETS IMMEDIATE BUSINESS NEEDS.

- **700 AI master's students** are enrolling in AI master's programs at Ontario universities in both core technical and complementary areas such as health and business, and are beginning to enter the workforce.

IN LESS THAN TWO YEARS, VECTOR HAS BECOME A PILLAR OF CANADA'S NATIONAL AI STRATEGY.

- Vector has evolved quickly from a government announcement in 2017, built from scratch, to working with **over 40 industry sponsors** of all sizes and sectors – from construction, to retail, to finance – who benefit from access to the Vector Institute's AI talent community and programs that build their capacity to adopt AI.
- A growing supply of local talent is creating demand, causing leading companies to expand in Canada. Since Vector's launch, there have been 44 corporate AI and technology-related investment announcements in Canada, including announcements made by Accenture, Amazon, Deloitte, Facebook, Google Brain, IBM, Intel, LG Electronics, Microsoft, NVIDIA, Samsung, Shopify, Thomson Reuters, Uber, and others.

1 CBRE. "2019 Scoring Tech Talent." 2019. https://www.cbre.ca/en/research-and-reports/Scoring-Tech-Talent-in-North-America-2019

2 CBRE, 2019.

3 CBRE, 2019.

4 CBRE, 2019.

5 PwC Canada | CB Insights MoneyTree Canada report | Q4 & Full-Year 2018

6 *The Economist*. "Tomorrow's Innovation Hotspots." 2019. https://innovationmatters.economist.com/pdf/tomorrowsinnovationhotspots.pdf

7 Economic analysis prepared by Stokes Economics for the Vector Institute, December 12, 2018.

8 Amii. Mila. Vector Institute.

Canada is leading the way.

THE VECTOR INSTITUTE'S PROGRAMS ARE EXPANDING RAPIDLY, WITH EVER-INCREASING ENGAGEMENT AND PARTICIPATION FROM CANADIAN-BASED INDUSTRY.

- **More than 800 industry sponsor engagements** have been fulfilled by the Vector Institute's programs which are focused on business planning, idea flow and knowledge transfer, technical skills, and industry-research interactions.

THE VECTOR INSTITUTE IS DELIVERING ON ITS PROMISE TO GROW THE AI ECOSYSTEM.

- The Vector Institute is now a community of over **320 active researchers** with expertise in a wide range of domains within the field of AI. This community includes:
  - 26 Faculty Members (more than triple the number of founding Faculty Members)
  - 62 Faculty Affiliates
  - 41 Postgraduate Affiliates
  - 197 Post-Doctoral Fellows and students (including PhDs, master's, and research interns)
- As well as holding appointments or studying at universities across Canada, researchers at Vector gain access to a collaborative community based in Toronto's MaRS Discovery District and computing resources to catalyze foundational research and specific applications in areas such as health care and business.

CANADA IS LEADING THE WAY.

- The Vector Institute helped Canada become the **first country in the world to launch a national AI strategy**, supported by pillars of AI research Richard Sutton at Amii in Edmonton, Yoshua Bengio at Mila in Montreal, and Geoffrey Hinton at the Vector Institute in Toronto.[9]
- Canadian-based AI research pioneers Geoffrey Hinton and Yoshua Bengio received the 2018 ACM A.M. Turing Award, often referred to as the **"Nobel Prize" of computer science**, for their foundational research in deep learning and neural networks. New York-based co-recipient Yann LeCun completed his Post-Doctoral work under Hinton at the University of Toronto and is now Chief AI Scientist for Facebook AI Research.

Left to right: Cherri Pancake (President, ACM), Yann LeCun (Professor at New York University and VP and Chief AI Scientist at Facebook), Geoffrey Hinton (VP and Engineering Fellow of Google, Chief Scientific Advisor, Vector Institute, and University Professor Emeritus at the University of Toronto), Yoshua Bengio (Professor at the University of Montreal and Scientific Director at Mila), Jeff Dean (Google Senior Fellow), Vicki Hanson (CEO, ACM).
Photo courtesy of Association for Computing Machinery

- Since Vector's launch, corporate and government delegations from around the world — Australia, China, Germany, Japan, The Netherlands, Singapore, and institutions from across the US — have all sought out the Vector Institute's expertise. The Vector Institute has become an exemplary model for building an AI ecosystem with a rapidly expanding talent pool and ever-increasing investment anchored by the top research talent.

WHAT'S GOOD FOR THE AI ECOSYSTEM IS GOOD FOR CANADA.

- Job creation and investments announced since the launch of the Vector Institute are expected to result in a **10-fold return on governments' investments.**[10]
- AI research taking place across institutions stands to improve the lives of Canadians, improving health outcomes and more efficient delivery of public resources. The Vector Institute is supporting projects such as warning systems that sound an alarm well before a hospital patient needs to be transferred to the ICU, and the application of image recognition to improve diagnosis of radiology images and, in partnership with Public Health Ontario, identify tick species that could carry the bacteria that causes Lyme disease.
- On account of the strength the Canadian AI ecosystem, Canada's organizations are better able to withstand increasingly aggressive offers to lure talent away from Canada to other jurisdictions.

9 Dutton, Tim. "An Overview of National AI Strategies." Politics + AI, June, 28, 2018, https://medium.com/politics-ai/an-overview-of-national-ai-strategies-2a70ec6edfd

10 Economic analysis prepared by Stokes Economics for the Vector Institute, December 12, 2018.


EXIT
EXIT
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MISSION & VISION

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.

Mission

Vector 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.

Message from the Board Chair

Vector's establishment was a magic moment of collaboration. The Government of Ontario, the federal government through CIFAR, businesses, and AI researchers aligned behind the idea of creating a top AI institute in Toronto to reverse the brain drain of Canadian AI talent. They moved quickly to make it happen and in the two years since its launch, Vector's achievements have been outstanding.

We are continuously hearing examples of how Canadian industry, from businesses across sectors, from finance to manufacturing, are seeing return-on-investment as a result of AI adoption. Vector is currently leading three separate consortia of Canadian-based companies to help them adopt AI, and industry has regular access to networking and recruitment opportunities where they can interact with individuals from a large pool of machine learning researchers and AI master's candidates. More than 800 attendees from Vector industry sponsors have participated in its exclusive programs, including technical training and education on business strategy.

Vector has helped create the conditions for a virtuous cycle of talent attraction, increased investment, and the creation of good paying jobs. Because of this, Canada is rightly seen as a leader in the AI technological revolution. Yet global competition has risen, and we must now consider what it will take to sustain long-term success and solidify Canada's position as a world leader in AI.

In order to achieve our potential and solidify Canada's place as a global leader, we need to keep the talent machine moving over the long-term through further investments in education. We need to apply AI in public and private institutions.

Since Canada became the first country to announce a national AI strategy two years ago, over 20 countries have announced commitments to AI development. The global race for AI supremacy is on.

For Canada to win, we need to do more than just feed the talent machine. We need to translate that talent into economic and social benefit. Our concentration of world-class machine learning scientists is a major opportunity to turn expertise into economic competitiveness. Yet, Canada is often great at research, but poor at application. This cannot be the case with AI. Our companies and government institutions should be better than their counterparts anywhere in the world at using AI.

The ability to use AI to improve efficiency, develop new products, and achieve better outcomes for both customers and the public good will be the ultimate hallmark of national winners.

There is enormous transformative potential in AI and organizations are evolving to handle the complex interdisciplinary questions it is already introducing. Right here in Toronto, the largest ever donation to the University of Toronto established the Schwartz Reisman Institute for Technology and Society, with which Vector will soon co-locate. The new institute will support meaningful collaborations and foster cross-disciplinary solutions to the profound challenges spawned by rapid technological shifts, including digital governance principles.

What will the roles of government and business be in maximizing Canada's economic opportunity while protecting Canadians' rights and values? Will we be leaders or laggards? Only when Canada begins to lead these discussions can we truly pull away from the pack.

In order to achieve our potential and solidify Canada's place as a global leader, we need to keep the talent machine moving over the long-term through further investments in education. We need to apply AI in public and private institutions. We must crack the code on how to help our startups become sustainable world-class competitors that remain in Canada. We need to address through well-informed AI policy the issues that will arise as AI becomes more widespread. We need continued support for our institutes so they can attract top practitioners from around the world along with immigration policies that welcome them. And we need to commit to ensuring that the economic and social benefits of AI are truly shared across all Canadian workers and citizens.

We've grown the talent base needed to accomplish this. So let's not waste it.

ED CLARK
BOARD CHAIR

Message from the President and CEO

In January 2018, I returned home to Canada after 30 years in the US to lead the Vector Institute in executing its ambitious vision: to make Canada a world-leader in AI by giving Canadian organizations access to scarce AI talent and training.

With Geoffrey Hinton as its Chief Scientific Advisor and Richard Zemel as its Research Director, the institute had already assembled a small group of professors. But, we wanted to grow a much bigger community – the people who would train the next generation of an AI workforce that would ensure Canadian leadership in the field. By early 2018 we had built a collaborative workspace with AI computing infrastructure and opened our doors to the community.

We simultaneously reached out to our select collection of industry sponsors – a visionary group of Canadian-based companies and Canadian-based R&D units of multinational companies who had committed to Vector's vision and were eager to start learning from our community's leading-edge research. Today, these companies are turning to Vector for AI and machine learning training that spans introductory courses to the latest technological advancements and strategic insights. As more companies identify AI-enabled opportunities from which they can derive value, Vector will be alongside helping them. We facilitate AI deployment in cross-sector collaborations; inform strategic considerations; upskill staff; and provide exclusive access to some of the largest gatherings of highly qualified job-seekers in the field.

Canadian industry will develop the people and knowledge it needs to generate return-on-investment from AI solutions and compete globally; trainees will find good paying jobs; institutions will realize public benefits such as better and more efficient health care; startups will find customers and investors, scale in Canada, and compete globally.

The goal of Vector's founders was always to build a home for hundreds of graduate researchers and faculty. Today, both talent and businesses are choosing Canada thanks in part to the thriving ecosystem we helped create. We are now a research community of more than 320, and have nearly tripled our founding Faculty Members to 26, many of whom chose to immigrate or return home to Canada in spite of competitive offers to lure them elsewhere. A further 700 students are enrolling in AI master's programs across Ontario. This next generation of AI technology talent could easily leave for opportunities abroad. We need to make Canadian-based businesses and institutions a compelling choice for them.

This year Vector experienced an incredibly rare and celebrated honour. The legacy of the country's pioneering role in deep learning and its impact on all of computer science was recognized when the Association for Computing Machinery awarded this year's A.M. Turing Award to Vector's Chief Scientific Advisor, Geoffrey Hinton. For their groundbreaking work with deep neural networks, he shares the award, often called "the Nobel Prize of computer science," with colleagues Yoshua Bengio, Scientific Director of Vector's sibling organization Mila, and Yann LeCunn, Chief AI Scientist at Facebook and a former postdoctoral fellow under Hinton.

As we look forward, Vector will continue to play a leadership role in Ontario's AI ecosystem, bringing together universities, governments, startups, scaleups, incubators, accelerators, and venture capitalists to continue to strengthen the talent pipeline and help local companies succeed and transform. The goal is to unleash the transformative potential of AI, while enhancing the province's economic competitiveness.

Ensuring that our partners reap the full benefit of Vector's environment will be our primary challenge. Our researchers will continue to lead in the field and publish prolifically around the world; Canadian industry will develop the people and knowledge it needs to generate return-on-investment from AI solutions and compete globally; trainees will find good paying jobs; institutions will realize public benefits such as better and more efficient health care; startups will find customers and investors, scale in Canada, and compete globally.

The world is awakening to the awe-inspiring scope of AI's economic and social potential and countries are investing heavily, but Vector is ready for the challenges that lie ahead. Our competition is not slowing down and neither are we. We are grateful to all of our partners in industry and academia as well as the continued confidence of the federal and provincial governments who have supported us on this journey for the last two years. We are in a strong position to achieve our vision of Canada as a global leader in AI.

GARTH GIBSON
PRESIDENT AND CEO

EXPANDING OPERATIONS

Today the Vector Institute works with over 40 industry sponsors of varying sizes and sectors and many affiliated institutions. In 2018-19 – Vector's second year of operations – the institute significantly expanded its operations to support its dual mandate to host a rapidly expanding community of world-class researchers and facilitate knowledge transfer for Canadian industry and institutions.

Expanding Operations

FACILITIES

The Vector Institute is conveniently located in the MaRS Centre, which is strategically located between the University of Toronto and the surrounding research hospitals. Vector is easily accessible by local transit, including to and from Toronto Pearson International Airport. As a result, Vector has effectively brought hundreds of researchers together, hosted a series of international machine learning speakers and executed some of the country's largest AI career fairs and research gatherings.

Vector's community has grown rapidly: Nearly 200 faculty, graduate researchers and staff access Vector's office space in the MaRS building on a weekly basis. To accommodate this growth, in Fall 2018, Vector expanded its footprint in MaRS by 30 per cent.

Since taking occupancy in December 2017, Vector has held 25 education and collaboration sessions for industry and more than 70 talks and seminars, bringing together the local AI community like never before.

Plans to accommodate Vector's growing community are underway, with Vector named as an anchor tenant of the soon-to-be-built Schwartz-Reisman Innovation Centre.

COMPUTING

Computing power is among the most important resources for Vector's research community. Computing resources available in academic settings are often scarce and constrained as students run experiments ahead of major machine learning conference deadlines. Vector has addressed this bottleneck by:

- More than doubling the computing power available to the Vector community.
- Provisioning access to Amazon's AWS, Microsoft's Azure and Google's GCP cloud resources.
- Partnering to construct and update the Health AI Data Analysis Platform (HAIDAP), a secure, high-performance computing environment that makes de-identified population-wide health data available for AI, machine learning and other compute-intensive advanced analysis.

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
- Ryerson University
- St. Michael's Hospital
- Sunnybrook Hospital
- University Health Network
- University of British Columbia
- University of Guelph
- University of Toronto
- University of Waterloo
- Western University
- York University

Vector's community has grown rapidly: Nearly 200 faculty, graduate researchers, and staff access Vector's office space in the MaRS Centre on a weekly basis.

FUNDING

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 42 industry sponsors; 27 make up Vector's Platinum, Gold, and Silver level sponsors that provide direct funding while 15 AI-based startups and scaleups (Bronze Sponsors) play a vital role in the Ontario AI ecosystem by contributing time and expertise.

Additionally, the Vector Institute is in receipt of $10 million through Ontario's Ministry of Economic Development, Job Creation and 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.

The Vector Institute will take a place in the soon-to-be-built **Schwartz Reisman Innovation Centre**, creating the country's largest university-based innovation hub. The Centre is being made possible by a $100 million donation from Gerald Schwartz and Heather Reisman — the largest in the University of Toronto's history and the largest gift ever to the Canadian innovation sector.

The Vector Institute plans to occupy the top three and half floors in the 13-storey tower, which will also house the recently announced Schwartz Reisman Institute for Technology and Society.


WEISS/MANFREDI


WEISS/MANFREDI

EXPANDING THE AI TALENT PIPELINE

Vector was created to solve one of Canada's most vexing economic problems: a rapidly growing global demand for top AI talent and a comparatively thin supply.

Expanding the AI Talent Pipeline

Vector was created to solve one of Canada's most vexing economic problems: a rapidly growing global demand for top AI talent and a comparatively thin supply. It is committed to training and seeding an AI workforce that has already incented major corporations to locate and expand labs in Canada.

While US schools are capping enrollment as faculty accept jobs in corporate labs, Canada is addressing these issues head on; the country has succeeded in retaining, repatriating, and attracting some of the world's best AI professors, giving them flexibility to teach, consult, pursue entrepreneurship, or even lead corporate labs.

At Vector, what started as a small group of Faculty Members is now a research community of over 320 people (on track to grow to 400-500 researchers) who have regular opportunities to connect with Canadian-based industry to work on specific applications.

Marzyeh Ghassemi joined the University of Toronto's Departments of Computer Science and Medicine and the Vector Institute in July, 2018 after completing her PhD at MIT. "Toronto is known internationally for both innovative machine learning, and cutting-edge medical practice. This combination of natural resources makes it a fantastic place to lead in Machine Learning for Health," says Marzyeh.

Alán Aspuru-Guzik relocated his lab from Harvard and joined the University of Toronto and the Vector Institute in March, 2018. "Vector is a great environment for exposing my research group to the frontier of artificial intelligence," says Alán.

At Vector, what started as a small group of Faculty Members is now a research community of over 320 people on track to grow to 400-500 researchers.

CAREER FAIRS: CONNECTING AI TALENT TO LOCAL INDUSTRY

Vector hosts some of the largest networking events for AI job seekers and Canadian employers.

Vector capped off the 2018 CIFAR-Vector Deep Learning and Reinforcement Learning Summer School with an AI Job and Data Fair that brought together more than two dozen Vector industry sponsors and 500 AI graduate researchers, faculty, and job seekers from 60 different countries.

MANULIFE OFFERS INTERNSHIP ON-THE-SPOT AT VECTOR JOB & DATA FAIR

During Vector's July 2018 Job and Data Fair, Vector industry sponsor Manulife offered an internship to one of the summer school's PhD attendees on the spot. "From a technical perspective, Vector's screening of the summer school participants had already picked the right people," says Eugene Wen, Manulife's Vice President, Group Advanced Analytics. We were also quite impressed by her qualifications and attitude and she completed her term with substantial contributions to the team and projects."

Enhancing and expanding AI master's programs

The Vector Institute is ensuring that industry and institutions can access AI talent sooner by awarding scholarships to master's students admitted to AI disciplines in Ontario. Across Ontario, universities are expanding enrollment in AI programs and developing new ones to meet the growing demand of the field. By connecting these students to internship and career opportunities across a range of industries, Vector will foster a robust community and maximize labour force attachment of these graduates. As of March 31, 2019 there have been 145 recipients of the merit-based Vector Scholarships in Artificial Intelligence (VSAI).

As of March 2019, there were 16 Vector-recognized AI master's programs in Ontario. Each program meets essential requirements that equips its graduates

with the skills and competencies sought by industry. More than 200 master's students are enrolled in recognized programs and a further 192 students in individual AI-related study paths.

There are now more than 700 AI master's students enrolling in AI master's programs at Ontario universities in both core technical and complementary areas such as health and business. The new Vector Scholarship in Artificial Intelligence helped drive up the overall number of applicants to Ontario universities.

In December 2018, Vector hosted an exclusive networking reception for its industry sponsors to meet the first 66 recipients of the Vector Scholarship in Artificial Intelligence.

Akshay Budhkar was studying under Vector Faculty Member Frank Rudzicz when Canadian investment fund, Georgian Partners, offered him an internship. Connected on LinkedIn due to their mutual involvement with Vector – Georgian is one of Vector's industry sponsors – the company had a natural language processing project that aligned with Akshay's master's research.

The internship went well, and Akshay was offered a full-time position.

"I decided to accept, in lieu of accepting my PhD offer, because at Georgian I still get to work on research while applying it to real-world problems in our portfolio."

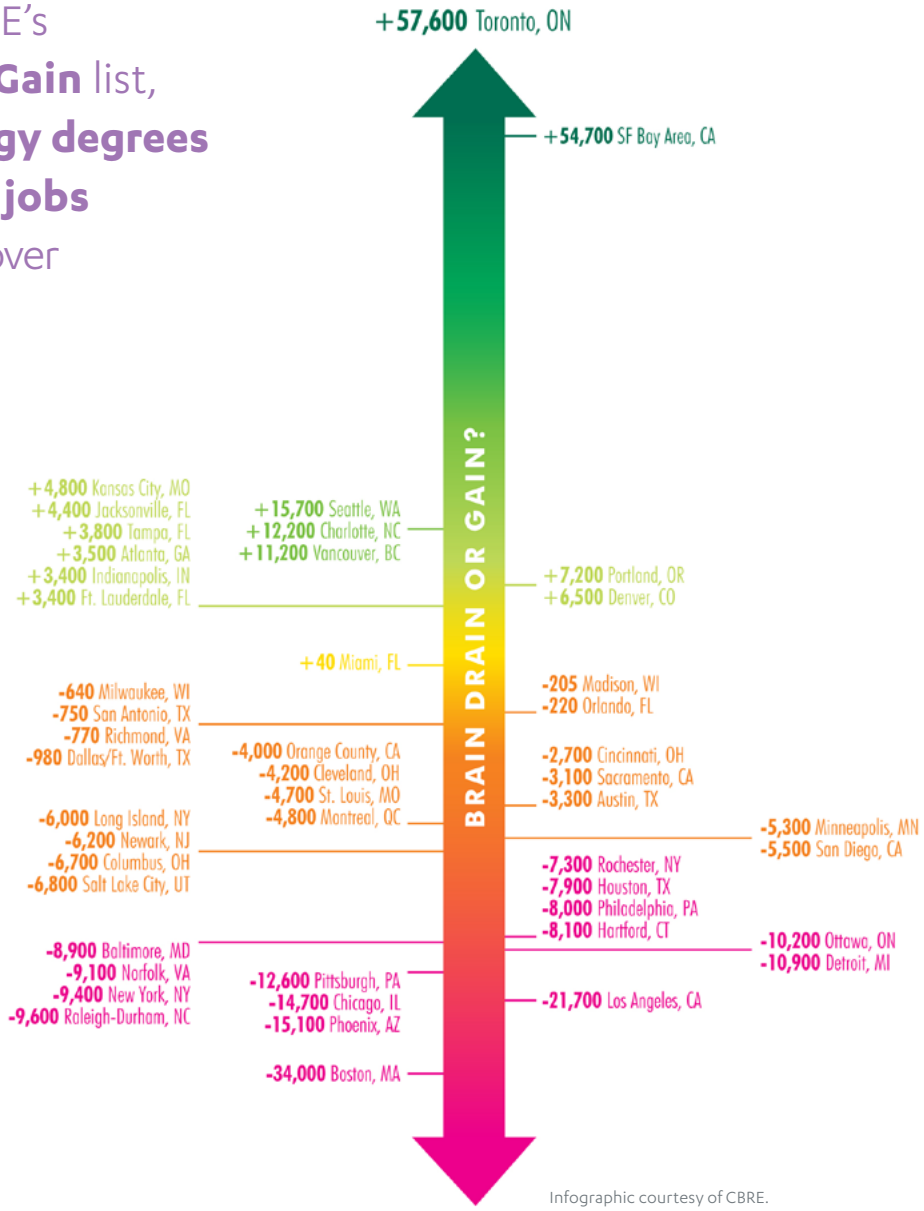
He continues to collaborate with the Vector community through a Vector-led industry innovation project.

Brain gain

Toronto topped the CBRE's **North American Brain Gain** list, adding **22,466 technology degrees** and **80,100 technology jobs** resulting in a net gain of over **57,600 technology jobs**.

For two consecutive years, Toronto has topped the CBRE's "Brain Gain" list as the largest net gainer of talent in North America with an excess of over 57,600 technology jobs added over tech degrees granted between 2012-2018.[11] Moreover, Toronto is among the top 10 highest producers of technology degree graduates and has the fastest growing technology labour pool in North America, increasing by 54 per cent in 2018. Toronto also ranks among the top five most concentrated tech talent markets in North America.

Along with Montreal, Ottawa, and Vancouver, Toronto is among the most affordable technology markets in North America in terms of employee wages and office rent. These cities provide the best value in terms of cost and quality, due in part to the strong US dollar.



Infographic courtesy of CBRE.

11 CBRE, 2019

MACHINE LEARNING RESEARCH

20/21

Enabling and amplifying the impact of a world-class AI research community is core to Vector's mission.

Pushing the Boundaries of Machine Learning Research

Enabling and amplifying the impact of a world-class AI research community is core to Vector's mission. Besides driving new breakthroughs in the field, this community is also ground zero for the talent pipeline Vector has created. Vector Researchers are part of a base of world-class talent whose presence encourages other top researchers from across the world to come to Canada for the chance to collaborate and network. Put simply: the best people come here because the best people are already here. In turn, the best companies also invest in Canada as they seek supply to meet their growing demand for talent.

This has knock-on effects as new companies are spun out into the Canadian ecosystem and new generations of AI researchers get both classroom and hands-on training from some of the best minds in the field.

GROWING RESEARCH COMMUNITY

There are now more than 600 researchers across the three Pan-Canadian AI institutes. Over 320 of those are affiliated with Vector, including:

- **26** Faculty Members (more than triple the number of founding Faculty Members)
- **62** Faculty Affiliates
- **41** Postgraduate Affiliates
- **197** Post-Doctoral Fellows and students (including PhDs, master's, and research interns)

The following Faculty Members joined the Vector Institute in 2018-19:

- **Alán Aspuru-Guzik**
  Canada CIFAR AI Chair & Faculty Member, Vector Institute; Canada 150 Research Chair in Theoretical & Quantum Chemistry; Professor, Department of Computer Science and Chemistry, University of Toronto; Chief Scientific Officer, Zapata Computing; Chief Vision Officer, Kebotix.
- **Jimmy Ba**
  Canada CIFAR AI Chair & Faculty Member, Vector Institute; Assistant Professor, Department of Computer Science & Machine Learning Group, University of Toronto
- **Shai Ben-David**
  Faculty Member, Vector Institute; Professor, David Cheriton School of Computer Science, University of Waterloo
- **Murat Erdogdu**
  Canada CIFAR AI Chair & Faculty Member, Vector Institute; Assistant Professor in Computer Science and Statistics, University of Toronto
- **Marzyeh Ghassemi**
  Canada CIFAR AI Chair & Faculty Member, Vector Institute; Assistant Professor in Computer Science and Medicine, University of Toronto
- **Sara Mostafavi**
  Canada CIFAR AI Chair & Faculty Member, Vector Institute; Assistant Professor, Department of Statistics and the Department of Medical Genetics & Affiliate Member, Department of Computer Science, University of British Columbia
- **Leonid Sigal**
  Canada CIFAR AI Chair & Faculty Member, Vector Institute; Associate Professor, Department of Computer Science, University of British Columbia; Scientific Advisor, Borealis AI
- **Bo Wang**
  Canada CIFAR AI Chair & Faculty Member, Vector Institute; Lead Artificial Intelligence Scientist, Peter Munk Cardiac Centre at the University Health Network; Assistant Professor, University of Toronto

There are now more than 600 researchers across the three Pan-Canadian AI institutes. Over 320 of those are affiliated with Vector.

CANADA CIFAR AI CHAIRS

Part of the $125 million Pan-Canadian AI Strategy, Canada CIFAR AI (CCAI) 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 around the world.

In 2018-19, the following Vector Faculty Members were granted CCAI Chairs:

- **Alán Aspuru-Guzik**
  Canada CIFAR AI Chair & Faculty Member, Vector Institute; Canada 150 Research Chair in Theoretical & Quantum Chemistry; Professor, Department of Computer Science and Chemistry, University of Toronto; Chief Scientific Officer, Zapata Computing; Chief Vision Officer, Kebotix
- **Jimmy Ba**
  Canada CIFAR AI Chair & Faculty Member, Vector Institute; Assistant Professor, Department of Computer Science & Machine Learning Group, University of Toronto
- **Murat Erdogdu**
  Canada CIFAR AI Chair & Faculty Member, Vector Institute; Assistant Professor in both Computer Science and Statistics, University of Toronto
- **Juan Felipe Carrasquilla**
  Canada CIFAR AI Chair & Faculty Member, Vector Institute; Adjunct Assistant Professor, Faculty of Science, Department of Physics and Astronomy, University of Waterloo
- **Amir-massoud Farahmand**
  Canada CIFAR AI Chair & Faculty Member, Vector Institute; Assistant Professor at the Department of Computer Science and Department of Mechanical and Industrial Engineering, University of Toronto
- **Sanja Fidler**
  Canada CIFAR AI Chair & Faculty Member, Vector Institute; Assistant Professor, Department of Computer Science and Department of Mathematical and Computational Sciences, University of Toronto
- **David Fleet**
  Canada CIFAR AI Chair & Faculty Member and Associate Research Director, Industry Innovation, Vector Institute; Professor, Department of Computer Science and Department of Computer and Mathematical Sciences, University of Toronto; Senior Fellow, CIFAR
- **Marzyeh Ghassemi**
  Canada CIFAR AI Chair & Faculty Member, Vector Institute; Assistant Professor in Computer Science and Medicine, University of Toronto
- **Roger Grosse**
  Canada CIFAR AI Chair & Faculty Member, Vector Institute; Assistant Professor, Department of Computer Science, University of Toronto
- **Alireza Makhzani**
  Canada CIFAR AI Chair & Faculty Member, Vector Institute; Adjunct Professor, Department of Electrical and Computer Engineering, University of Toronto
- **Quaid Morris**
  Canada CIFAR AI Chair & Faculty Member, Vector Institute; Professor in the Donnelly Centre in the Faculty of Medicine at the University of Toronto with graduate appointments in Molecular Genetics and Computer Science; Associate Investigator, Ontario Institute for Cancer Research.
- **Sara Mostafavi**
  Canada CIFAR AI Chair & Faculty Member, Vector Institute; Assistant Professor, Department of Statistics and the Department of Medical Genetics & Affiliate Member, Department of Computer Science, University of British Columbia
- **Sageev Oore**
  Canada CIFAR AI Chair & Faculty Member, Vector Institute; Associate Professor, Faculty of Computer Science, Dalhousie University

- **Nicolas Papernot**
  Canada CIFAR AI Chair & Faculty Member, Vector Institute; Assistant Professor, Department of Electrical & Computer Engineering, University of Toronto
- **Pascal Poupart**
  Canada CIFAR AI Chair & Faculty Member, Vector Institute; Professor, David R. Cheriton School of Computer Science, University of Waterloo; Principal Researcher, Borealis AI
- **Daniel Roy**
  Canada CIFAR AI Chair & Faculty Member, Vector Institute; Assistant Professor, Department of Statistical Sciences and Department of Computer Science, University of Toronto; Department of Computer and Mathematical Sciences, University of Toronto Scarborough
- **Frank Rudzicz**
  Canada CIFAR AI Chair & Faculty Member, Vector Institute; Director of AI, Surgical Safety Technologies Incorporated; Scientist, International Centre for Surgical Safety, Li Ka Shing Knowledge Institute, St Michael's Hospital; Associate Professor, Department of Computer Science, University of Toronto
- **Leonid Sigal**
  Canada CIFAR AI Chair & Faculty Member, Vector Institute; Associate Professor, Department of Computer Science, University of British Columbia; Scientific Advisor, Borealis AI
- **Graham Taylor**
  Canada CIFAR AI Chair & Faculty Member, Vector Institute; Associate Professor, School of Engineering, University of Guelph; Academic Director, NextAI
- **Bo Wang**
  Canada CIFAR AI Chair & Faculty Member, Vector Institute; Lead Artificial Intelligence Scientist, Peter Munk Cardiac Centre at the University Health Network; Assistant Professor, University of Toronto

PUBLICATIONS & ACCOLADES

Vector researchers are frequently published in the world's top competitive machine learning conferences and journals. All told, Vector researchers published over 200 papers at world-leading conferences and peer-reviewed publications between April 2018 and March 2019. Toronto researchers were front and centre at NeurIPS 2018, where three of the four Best Paper awards handed out at NeurIPS 2018, the world's most important machine learning conference, were given to papers co-authored by members of the Toronto AI community.

ICLR 2018 – VANCOUVER, BRITISH COLUMBIA, APRIL 30-MAY 3, 2018

- Conference acceptance rate: **36 per cent**
- Vector papers accepted: **12**

CVPR 2018 – SALT LAKE CITY, UTAH, JUNE 18-22, 2018

- Conference acceptance rate: **29.5 per cent**
- Vector papers accepted: **8**

ICML 2018 – STOCKHOLM, SWEDEN, JULY 10-15, 2018

- Conference acceptance rate: **25 per cent**
- Vector papers accepted: **10**

NEURIPS 2018 – MONTREAL, QUEBEC, DECEMBER 3-8, 2018

- Conference Acceptance rate: **21 per cent**
- Vector papers accepted: **18**

Top Honours at NeurIPS 2018 go to Vector and Toronto

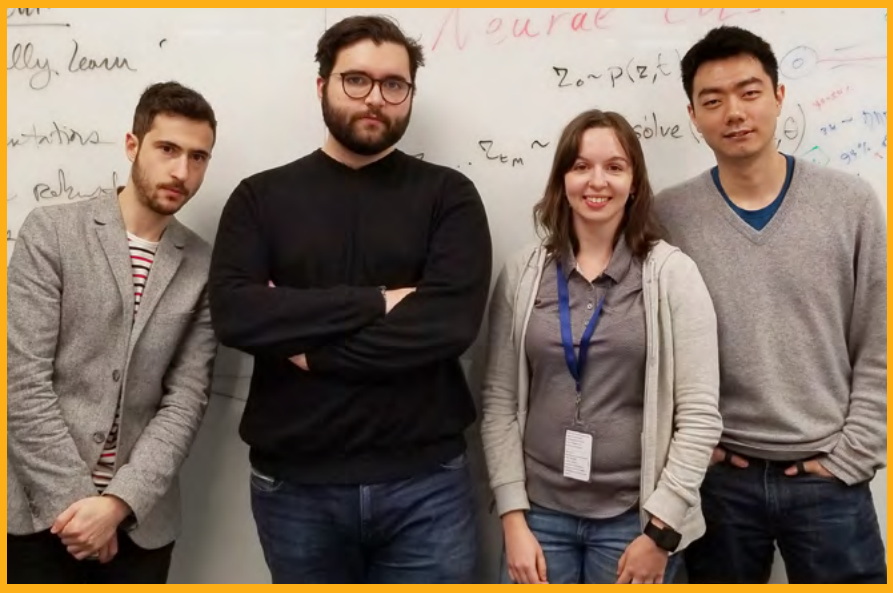


Photo: Left to Right – Will Grathwohl, Jesse Bettencourt, Yulia Rubanova and Ricky Chen

David Duvenaud

The work of Vector Faculty Members and students was recognized at NeurIPS 2018, the world's largest machine learning conference, where they won two of the four Best Paper awards and a Best Student Paper Award.

Vector co-founder and Faculty Member David Duvenaud and students Jesse Bettencourt, Yulia Rubanova, and Ricky Chen received one of the conference's Best Paper awards for their publication, "Neural Ordinary Differential Equations." The paper redesigns neural networks to better analyze continuous flows of data. It lays the groundwork for deep learning models that can better predict things like a medical patient's health over time.

Vector Faculty Member Shai Ben-David, Vector Postgraduate Affiliate Hassan Ashtiani, and co-authors Nick Harvey, Christopher Law, Abbas Mehrabian, and Yaniv Plan also won a Best Paper awards for "Nearly Tight Sample Complexity Bounds for Learning Mixtures of Gaussians via Sample Compression Schemes."

A third Best Paper Award was awarded to industry researcher, Craig Boutillier, who was a Professor in the University of Toronto's Department of Computer Science, and co-authors Tyler Lu and Dale Schuurmans for "Non-delusional Q-learning and Value Iteration."

Vector students Will Grathwohl, Ricky Chen, and Jesse Bettencourt in collaboration with Ilya Sutskever and David Duvenaud won the Best Student Paper Award for their paper, "FFJORD: Free-form Continuous Dynamics for Scalable Reversible Generative Models."

Vector's Chief Scientific Advisor, Geoffrey Hinton receives 2018 ACM A.M Turing Award alongside Yoshua Bengio and Yann LeCun

Left to right: Cherri Pancake (President, ACM), Yann LeCun (Professor at New York University and VP and Chief AI Scientist at Facebook), Geoffrey Hinton (VP and Engineering Fellow of Google, Chief Scientific Advisor, Vector Institute, and University Professor Emeritus at the University of Toronto), Yoshua Bengio (Professor at the University of Montreal and Scientific Director at Mila), Jeff Dean (Google Senior Fellow), Vicki Hanson (CEO, ACM).
Photo courtesy of Association for Computing Machinery

In March 2019, the Vector Institute's Chief Scientific Advisor, Geoffrey Hinton, received computer science's top distinction, the ACM A.M. Turing Award, for his foundational research in deep learning and neural networks. Hinton is also Vice President and Engineering Fellow at Google, and Emeritus Professor at the University of Toronto. The award celebrates scientists and engineers for propelling the field forward and making a significant technical impact. It comes with a $1 million, Google-sponsored prize.

Hinton shares the award with fellow Canadian, Yoshua Bengio, Professor at the University of Montreal and Scientific Director at Mila, and Yann LeCun, Professor at New York University and VP and Chief AI Scientist at Facebook, who did his postdoctoral research with Hinton at the University of Toronto. Together, they are considered the founding fathers of deep learning. Each has pushed the boundaries of understanding and possibility in computing.

The award capped off a year in which Hinton's achievements have yielded increasing accolades; in December, the Governor General of Canada appointed Hinton as a Companion of the Order of Canada and in February he was named 2019 Toronto Region Builder award recipient at a ceremony attended by Prime Minister Justin Trudeau.

Photos courtesy of Toronto Region Board of Trade

Photo courtesy of Association for Computing Machinery

Expanding research programs

Developing the future generations of top AI talent is key to maintaining Toronto and Canada's reputation as an international AI hub. To that end, Vector has established a number of events and programs aimed at deepening and enriching the community of AI researchers and practitioners in Ontario.

POSTGRADUATE AFFILIATES

Established in 2018, the Postgraduate Affiliates program promotes engagement and collaboration among researchers who are in the early stages of their careers and the broader AI community.

Vector welcomed 19 new Postgraduate Affiliates (both graduate researchers and Post-Doctoral fellows) who were evaluated based on the strength of their past research and the alignment of their interests with Vector's vision, mission, and research strengths. Demonstrating the high caliber of the incoming cohort, this year's acceptance rate was 8.6 per cent.

Vector was also excited to celebrate the successes of graduating members of the 2018 cohort, many of whom accepted positions at leading technology companies in Canada or faculty/scientist positions at notable Canadian institutions, expanding Vector's influence across the country.

RESEARCH INTERNS

Vector continues to nurture the next generation of world-class researchers through its internship program. Vector interns undertake research projects and engage in all parts of the research process, from reading relevant literature and running experiments to writing results for publications, they gain critical knowledge and the chance to work with some of the world's leading machine learning and AI researchers.

The program supports the introduction of talent from international institutions which can result in collaborations and allow for the pursuit of top talent globally. This year Vector hosted 12 research interns who came from prestigious educational institutions in North America and Europe, building on a diverse talent pipeline and furthering Canada's global AI leadership.

ACTIVITIES

RESEARCH SYMPOSIUM & JOB FAIR

In February 2018, Vector held its first-ever Research Symposium and Job Fair at the MaRS Discovery District – one of the largest gatherings of machine learning talent across Canada with over 300 attendees. The day-long event showcased work produced by Vector researchers produced over the last year. It was also an opportunity for local machine learning graduate researchers and Post-Doctoral fellows to connect with Vector's industry and health partners and discover a wide range of career opportunities. Tailored for Vector's industry sponsors and research community, the event had representatives from 20 Vector industry sponsors and health partners.

Hassan Ashtiani, Postgraduate Affiliate, 2018 came to Vector to continue his research around statistical learning theory and other core machine learning problems, drawn by its reputation as a hub for machine learning research and a desire to meet other researchers. Hassan has since joined the Department of Computing and Software at McMaster University as an assistant professor. "My wife and I are both ML researchers," he says, explaining why he chose to continue his career in Canada. "AI opportunities are ample in the GTA, plus Hamilton, Waterloo, and Guelph are conveniently close. I think the role of Vector will be critical in creating an ecosystem where AI/ML researchers across Ontario/Canada can conveniently connect, share, and collaborate."

Laleh Ghoraie, Postgraduate Affiliate, 2018 was drawn to Vector by its academic reputation as well as its broader vision. She pursued working on machine learning applications in cancer research while taking advantage of the networking opportunities at many Vector-sponsored events. She's since taken a job with Borealis AI, developing expertise in natural language processing. "Experts in this field used to leave the country to have better job options. Many of my colleagues during grad studies did it. But I don't think that it's necessary anymore," she says. "I personally enjoy living in Toronto and it has become one of the major hubs for what I've been trained for."

THE MACHINE LEARNING ADVANCES AND APPLICATIONS SEMINAR

"Fields Talks," as they are called in the community, are Vector's most popular seminar series. This public seminar is hosted in partnership with the Fields Institute and aims to strengthen the machine learning community in Ontario by bringing together researchers to hear about the latest advances in the field. The 2018-19 slate included talks by leading faculty and industry professionals from across North America, including Kevin Murphy (Google AI), Finale Doshi-Velez (Harvard), and Dan Jurafsky (Stanford). Open to the public, the talks attract faculty and graduate researchers from diverse educational backgrounds as well as local data scientists and other industry professionals from the AI sphere.

VECTOR FRIDAY SEMINAR

These weekly gatherings are a platform for Vector Faculty Affiliates to share their research with the community. They illustrate the diverse applications of machine learning in their respective fields, including computer science, engineering, medicine, health care, law, and fairness. Over the course of the year Vector hosted 22 Friday Seminars.

FUELING THE ECOSYSTEM

A robust ecosystem gives both enterprises and startups who are hungry for talent and expertise access to the world's top talent.

Fueling the Ecosystem

In AI, the brightest minds can be game-changers – the best researchers produce the best results. They also train the best people and turn companies into global competitors.

Aware of their potential to drive change and interested in collaborating with the world's best, individuals trained in AI seek to join vibrant AI ecosystems that offer a multitude of job opportunities in business or academia. A robust ecosystem gives both enterprises and startups who are hungry for talent and expertise access to the world's top talent. For those who are entrepreneurially minded, the ecosystem serves as a training ground where they can gain the skills and experience necessary to launch their own companies.

Thanks to Canada's well-earned reputation as a global AI hub and critical mass of AI talent, enterprises, startups, and post-secondary institutions alike are in direct competition with some of the world's strongest schools in computer science and technology companies for top AI talent and winning. Every time a Canadian institution or business recruits top AI talent, the entire ecosystem benefits. The Toronto region – with a population of 7.8 million in a country with fewer residents than the state of California – is punching above its weight.


Supporting a greener future
Soutenir un avenir plus vert

AI and Tech-Related Investments in Canada

March 31, 2017	**Google** bets on AI in Canada in Canada, launches Google Brain Toronto.
April 20, 2017	**IBM** to open an AI lab in Montreal to better collaborate with Mila.
May 8, 2017	**Uber** launches Advanced Technology Group (ATG) in Toronto, led by Raquel Urtasun.
July 5, 2017	**DeepMind** expands to Canada with new research office in Edmonton, Alberta.
August 15, 2017	**Accenture** launches Liquid Studio in Toronto and will hire 1,000 people in Canada.
September 15, 2017	**Facebook** launches AI research lab (FAIR) in Montreal, hiring 10 researchers to start, aiming to triple in the coming year.
October 6, 2017	**DeepMind** opening laboratory in Greater Montreal, bets on strong research community.
October 10, 2017	**Thales** launches Centre of Research and Technology in Artificial Intelligence eXpertise (cortAix), creating 50 new world class jobs for AI researchers and developers.
October 11, 2017	**Thomson Reuters** Celebrates its Toronto Technology Centre's First Anniversary with $100 million Expansion. The new site will accommodate up to 1,500 staff.
November 21, 2017	**Borealis AI** (RBC Institute for Research) to open new AI lab in Montreal.
January 19, 2018	**GM Canada** opens new Canadian Technical Centre (CTC) in Markham, Canada's largest new automotive and mobility software centre with more than 700 staff. Announces GM Canada STEM Fund.
January 23, 2018	**Microsoft** expands its Montreal research lab (Laboratoire de recherche Microsoft) and doubles staff to 75.
May 17, 2018	**Etsy** opens machine learning center in Toronto.
May 24, 2018	**Havas Group** creates AI innovation centre in Montreal that will employ 60 specialists in AI, data science, customer experience design and programming by 2020.
May 24, 2018	**Samsung** launches AI Centre in Toronto and will increase R&D staff in Canada to 200.
June 15, 2018	**NVIDIA** opens AI Research Lab in Toronto, plans to triple number of AI and deep learning researchers by year end.
August 1, 2018	**LG Electronics** to establish an AI research lab in Toronto and hire several dozen employees.
August 28, 2018	**Jumio** launches AI lab in Montreal to hone ID verification, hiring 30 engineers and specialists by the end of next year.

September 11, 2018	**Microsoft** announces new Canadian headquarters in downtown Toronto, growing staff by more than 500.
September 11, 2018	**Varian Medical Systems** creates center of innovation in Greater Montreal, triples staff count to 60.
September 12, 2018	**Intel** to open graphics-chip engineering lab in Toronto creating a home for dozens, if not hundreds, of engineers working on the chips.
September 13, 2018	**Uber** opening an engineering hub in early 2019 and expanding its Advanced Technologies Group (ATG) Research & Development Centre in Toronto, investing more than $200 million over five years. Overall headcount in Toronto will exceed 500 employees.
September 13, 2018	**Deloitte** Deloitte hiring hundreds of AI professionals across Canada, tripling its newly launched AI practice to approx. 1000 people.
September 20, 2018	**Facebook** expanding its Montreal AI lab to double the number of researchers. New facility to accommodate up to 60 people.
September 28, 2018	**Shopify** will invest up to $500 million in a new Toronto office.
October 19, 2018	**Samsung** Samsung opens second AI Center in Montreal.
November 13, 2018	**Coveo** expands Montreal office to 300 employees.
November 14, 2018	**Pixomondo** plans Montreal expansion, increasing staff to 180.
November 19, 2018	**DiDi** launches Labs in Toronto, expanding global research network to Canada.
November 26, 2018	**IBM**'s Client Innovation Centre in Montreal expands mission with Artificial Intelligence and Salesforce focus creating 100 jobs in 2019.
November 27, 2018	**Accenture** opens Canada Innovation Hub in Toronto, adding 800 new highly skilled technology jobs.
December 4, 2018	**QuantumBlack** announces new AI office opening in Montreal, adding up to 30 deep learning specialists and highly qualified data engineers.
December 4, 2018	**WinningMinds** opens AI center in Montreal.
December 4, 2018	**BIOS** opens AI center in Montreal.
December 18, 2018	**Amazon** expands technology hub in Toronto, creates 600 new jobs.
January 10, 2019	Japan auto parts supplier **Denso** to set up AI lab in Montreal.

BUILDING AI CAPACITY IN INDUSTRY

Companies investing in AI are seeing returns to the bottom line for doing so, and they can more easily hire the talent they need to enable these returns.

NVIDIA (Vector Platinum Sponsor)

"The Vector Institute and NVIDIA have been collaborative partners in driving industry education. One of the highlights this year has been working with Vector's industry sponsors to scale their state-of-the-art natural language processing implementations with GPUs."
– NVIDIA

Borealis AI (Vector Platinum Sponsor)

"Vector has a knack for finding the top AI researchers and developers and bringing them to Toronto where they not only find new and improved applications for AI but also train the next generation of Canadian AI talent."
– Borealis AI

Building AI Capacity in Industry

Canada's concentration of world-class machine learning researchers and rapidly growing AI workforce present major opportunities to turn knowledge into economic competitiveness.

Vector's industry sponsors are leaders in their fields with the initiative and vision to recognize AI as a rapidly advancing technology that will change the way Canadian companies compete globally. Through their sponsorship of Vector, each of them is taking the bold steps necessary to benefit from the broad, transformational potential of deep learning and machine learning.

> "Having the chance to talk with someone with as much broad experience as (Vector Faculty Member) Frank Rudzicz was invaluable. For example, his advice to not ignore the old methods, particularly with regards to text summarization, helped us significantly. Getting such excellent notes summarizing our conversation greatly increased the value of the meeting because it allowed us to concentrate fully on the conversation while also capturing some things that we missed. Thank you again for making these opportunities available to us.
>
> – Geoff Peddle, CTO, Tealbook

More than 800 attendees from over 40 industry sponsor companies have come through Vector's programs, which are focused on business planning, idea flow, knowledge transfer, technical skills, and industry-research interaction.

ACCESS TO TALENT & WORKFORCE DEVELOPMENT SUPPORT

Vector offers its industry sponsors access to some of Canada's top AI talent. Vector-hosted AI research-themed events paired with job fairs give industry sponsors opportunities to both learn about the latest machine learning research advancements while networking with the country's most promising machine learning graduate researchers.

These events are essential for companies seeking to fill permanent, internship, or consulting positions. Job-seekers arrive eager to learn about the real-world data and applications companies are working on.

TRAINING, UPSKILLING, AND KNOWLEDGE TRANSFER

In addition to Vector's expertise in machine and deep learning, Vector's community specializes in a range of areas and specific applications such as computer vision, reinforcement learning, health applications, natural language processing, sciences (e.g., chemistry and physics), statistics, optimization, music and creativity, security, and ethics.

Vector proactively facilitates opportunities for its industry sponsors to learn how these research areas can help their business.

ENDLESS SUMMER SCHOOL (ESS)

Vector's Endless Summer School is an ongoing series of technical workshops featuring the latest machine learning advances relevant to technical industry leaders. Presentations are given by prominent Vector researchers – who have been known to present their work at ESS before it is published – and industry experts, enabling the exchange of knowledge and ideas. These monthly workshops provide a recurring opportunity for industry sponsors to build relationships with other technical professionals and network with research leaders and graduate researchers.

A few of the topics explored during the nine sessions held in the past year included robotics, natural language processing, generative models, privacy, and fairness.

FACE-TO-FACE MEETINGS

These facilitated meetings between an industry sponsor and Vector researcher present opportunities to discuss technical machine learning challenges, emerging research trends, and recent technical developments. They allow industry sponsors opportunities to ask for advice, test their ideas, and seek out resources on a wide variety of machine learning problems.

Vector's industry sponsors are leaders in their fields with the initiative and vision to recognize AI as a rapidly advancing technology that will change the way Canadian companies compete globally.

AI FOR EXECUTIVES

Taking AI beyond code and into the boardroom where strategic decisions are made requires not only an understanding of how AI works, but also how companies can stay ahead of rapid change to mitigate risks while positively impacting business results and customer experience. AI for Executives is a series of non-technical workshops tailored to the needs of executives and senior management for Vector industry sponsors.

CONSORTIUM PROJECTS

As an independent, not-for-profit focused on research in machine and deep learning, Vector plays a unique role as a neutral third party to bring industry consortia together to cooperate on mutual challenges that affect Canadians.

Vector provides project management from ideation through to implementation for industry sponsors coming together to work on projects that advance joint technical and research-themed problems, gathering and acting on insights resulting from collaboration that individual companies would not be able to realize acting separately.

These projects facilitate cooperation and partnership among industry sponsors – sometimes among competitors who otherwise would not come together – to address machine learning problems.

FINANCIAL SERVICES SECTOR

95 participants from 13 different industry sponsors and regulators are supporting two projects in Canada's financial sector:

- **Consortium Workstream:** Vector is collaborating with Canada's financial institutions to develop new methodologies and algorithms to improve security and combat financial crime.
- **Regulatory Workstream:** Due to the risks introduced by advanced AI models, financial institutions must revisit the processes and controls around how AI models are handled in order to accelerate the impact of newer AI technologies in a responsible way. Vector, its industry sponsors, and Canada's financial regulators are joining forces to address top-of-mind regulatory concerns (i.e., fairness, interpretability, and model robustness), and to refresh approaches towards AI model management.

RE-RECREATION OF LARGE-SCALE PRE-TRAINED LANGUAGE MODELS

This project will enhance industry sponsors' ability to implement deep learning language models at scale. This includes training and fine-tuning existing large scale natural language processing models as well as integrating those models onto their internal pipeline to achieve higher performance.

IMPROVING OPERATIONAL ENERGY EFFICIENCIES THROUGH THE APPLICATION OF MODEL-BASED REINFORCEMENT LEARNING (MBRL)

In order to help industry sponsors meet targets for carbon footprint reduction and energy efficiency, this project looks at how reinforcement learning can be applied to improve the adaptability of environmental control systems.

Linamar Corporation (Vector Silver Sponsor)

Guelph-based Linamar is Canada's second-largest automobile parts manufacturer. By adopting intelligent systems, Linamar has increased employment by 47 per cent since 2011 and total wages by 76 per cent. In other words, Linamar is hiring more people into more interesting jobs and paying them more.[12]

12 Hasenfratz, Linda. "AI at Linamar." Machine Learning and the Market for Intelligence. Creative Destruction Lab. Rotman School of Management, Toronto, Canada, Oct 23, 2018, https://www.youtube.com/watch?v=UVOcKqqrevI

Vector's Industry Sponsors

The Vector Institute's industry sponsors[13] represent a cross section of Canada's diverse economy, including sectors such as health care, finance, insurance, education, retail, advanced manufacturing, and transportation. These organizations are either established Canadian enterprises, leading edge scaleups and startups, or international companies with a Canadian research presence. These companies are leaders in their fields who recognize AI as a rapidly advancing technology that will change the way Canadian companies compete globally.

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
- intergrate.ai
- Layer 6
- North
- ROSS Intelligence
- Wattpad

BRONZE 2018

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

BRONZE 2019

- BenchSci
- Canvass Analytics, Inc.
- Surgical Safety Technologies

13 As of March 2019


Image Search for Medical Images
CANCER CELLULARITY


layer 6

Enabling and vetting qualified startup solution providers

The Vector Institute's mission is to ensure that all Canadian industry, including startups and scale-ups, have the people and skills necessary for AI-enabled economic competitiveness. By attracting and retaining talent, Vector is ensuring there are more skilled people to support an AI-enabled labour force, whether that means conducting research, founding a startup, joining a large firm, or serving as a mentor or advisor to entrepreneurs and startups.

integrate.ai
(Vector Bronze Sponsor)

integrate.ai is a customer intelligence platform powered by AI that helps consumer businesses make precise predictions about customer needs. The company worked with Kanetix (online insurance quote aggregator), to leverage AI to optimize customer experience and increase its online conversion rate for auto insurance by 23 per cent in six months, more than doubling ROI in an environment where marketing and customer acquisition costs are rising.[14]

14 Lo, Alex. "Case Study: How Kanetix Ltd. leveraged AI to optimize customer experience." Kanetix Ltd, June 19, 2018, https://www.kanetixltd.ca/2018/06/case-study-kanetix-ltd-integrated-ai-optimize-customer-experience/

INTRODUCTORY AI WORKSHOPS

Aimed at educating SMEs, participants come away from the introductory workshops with increased AI literacy and new ways to think about deploying it in their businesses. The Vector Institute has piloted these workshops with MaRS, Communitech, and the OCE Discovery Conference and will explore opportunities to leverage this curriculum to increase AI literacy across companies and the public.

ENCOURAGING ENTREPRENEURIAL RESEARCHERS

Vector supports its researchers who are entrepreneurially inclined by providing education on IP hygiene, record-keeping, and IP and contract law through a series of education sessions on commercialization. The sessions facilitate access to successful local entrepreneurs as mentors, promising startups and scale-ups focused on AI, and local AI incubators and accelerators such as the Creative Destruction Lab at the Rotman School of Management.

BRONZE SPONSORSHIP PROGRAM

Qualified AI startups and scaleups in Ontario are invited to join Vector's Bronze level sponsorship program. The program directly addresses the scarcity of AI talent and the fact that challenges with accessing AI talent are often amplified for new or small companies. Bronze sponsors of the Vector Institute gain access to highly specialized machine learning education and training and opportunities to network with and recruit from Vector's community of world-leading faculty and graduate researchers. In return, Bronze sponsors contribute in-kind and share their own expertise and experience as entrepreneurs in the field.

Four new Bronze sponsors joined the Vector Institute this year.

BenchSci is a biomedical startup founded in 2015 and funded by iNovia, Real Ventures, and Gradient Ventures (Google's VC fund for early stage AI) among others. Their mission is to help scientists run more successful experiments to accelerate drug discovery. Their solution uses machine learning to process scientific literature and produce easily searchable results. Over 31,000 researchers at over 3,600 academic institutions and 15 of the top 20 pharmaceutical companies now use BenchSci.

Canvass Analytics is a leader in automating intelligent industrial operations through its AI-powered predictive analytics platform. Founded in 2016, it has funding from Real Ventures and Gradient Ventures (Google's VC fund for early stage AI) among others. It provides an enterprise grade platform for industrial customers to implement and scale automated industrial operations in a matter of days, using its pre-built predictive models pipeline. Companies, including leading, global automotive, aerospace, energy, and food and agriculture firms, use the platform to automate complex production processes, generate new revenue streams, and create new markets by producing higher grade products.

Surgical Safety Technologies is a startup that uses surgically trained AI to analyze, classify, and deconstruct risks from audio-visual, sensor, and medical device operating room data to improve value of care and patient outcomes. SST's core product, the OR Black Box® platform, is the first and only comprehensive surgical safety system that allows health care teams to learn from every team and patient interaction. Inspired by the aviation industry's proven investment in safety and transparency with the airline black box and flight data analytics, the platform similarly ensures all patient care areas are protected by a state-of-the-art safety system.

MindBridge Analytics is a venture-backed financial technology company based in Ottawa, Canada. Through the power of human-centric AI, MindBridge Analytics helps organizations deliver rapid value to their clients with deeper insights and higher risk assurance for one-hundred per cent of their data. With Ai Auditor, the world's first AI-powered auditing solution, organizations across multiple industries are augmenting human capacity to restore confidence in their financial data.

Canvass Analytics (Vector Bronze Sponsor)

Canvass Analytics harnesses machine learning to help metals, auto, agriculture and energy plants adapt to a rapidly innovating world. Humera Malik, CEO, says these industries tend to be "data-rich but information-poor" and often need a nudge to use data to their advantage. For one Canadian metal processor, Canvass uses temperature and raw-material composition data to predict the quality of final products and reduce waste. Another client was running its natural gas turbines at full capacity 24-7 no matter its electricity demands; Canvass's software was able to predict energy demand so the company could cut down on fuel consumption and wear and tear.[15]

15 Semeniuk, Ivan, Josh O'Kane, Sean Silcoff, and John Daly. "The chosen few: We asked Canada's business leaders to nominate the brightest minds you've never heard of." *Globe and Mail: Report on Business Magazine*. February 25, 2019. https://www.theglobeandmail.com/business/rob-magazine/article-the-chosen-few-we-asked-canadas-business-leaders-to-nominate-the/

IMPACT BEYOND COMPUTER SCIENCE AND TECHNOLOGY

Organizations around the world are recognizing the transformative potential of AI and beginning to grapple with its broader implications.

Impact Beyond Computer Science and Technology

AI & SOCIETY

Organizations around the world are recognizing the transformative potential of AI and beginning to grapple with its broader implications. Educational institutions such as MIT and Stanford have established interdisciplinary centres for innovation and ethics. Meanwhile, businesses are developing ethical AI principles and hiring ethicists to help navigate a new world.

CIFAR's AI & Society program, the Access Now and Amnesty International-backed "Toronto Declaration: Protecting the Right to Equality and Non-Discrimination in Machine Learning Systems" and the "Montreal Declaration for a Responsible Development of Artificial Intelligence" are examples of how Canadian institutions are beginning to grapple with these questions.

Vector will leverage its expertise to contribute meaningfully to actionable solutions to these complex challenges. Its researchers are already applying their expertise to tackle questions like algorithmic bias, decision making, fairness, differential privacy, ethics, accountability, transparency, and digital governance.

SCHWARTZ REISMAN INSTITUTE FOR TECHNOLOGY & SOCIETY

The largest ever donation to the University of Toronto will, among other objectives, establish the Schwartz Reisman Institute for Technology and Society. Its goal is to ensure emerging technological innovation is implemented fairly and equitably in societies around the world. Adopting an interdisciplinary approach, the institute will connect research across the sciences, social sciences, the humanities, and other fields to find concrete solutions.

The Institute for Technology and Society will be co-located with the Vector Institute in the soon-to-be-built Schwartz Reisman Innovation Centre. As such, Vector and its community of machine learning experts will be able to participate in important conversations and interdisciplinary research around broad societal impacts of AI.

AI & HEALTH CARE

Over the past 12 months, Vector has greatly accelerated its work at the intersection of health and AI research, building the foundation through three interconnected workstreams: World-Class Research, Widespread Application, and Analysis-Ready Accessible Data.

Vector has expanded the pool of Faculty Members and Affiliates working in the health field, and forged research partnerships with world-leading health care institutions. Notably, Vector Faculty Member Anna Goldenberg was named Varma Family Chair of Medical Bioinformatics and Artificial Intelligence at The Hospital for Sick Children (SickKids). A $3.5 million donation, the first-of-its-kind position at a children's hospital in Canada, will enable Goldenberg and colleagues to further existing health-AI research while pursuing new lines of inquiry.

There are opportunities for health AI research and innovation that can create wide-ranging societal good, and Ontario is uniquely positioned to take advantage. Working with its health partners, Vector is helping to forge the infrastructure necessary for researchers to safely access health data from the province's single-payer system. Held and shared under strict rules, the data offer an unparalleled opportunity for AI research and innovation. Vector is also supporting projects that aim to deploy and integrate AI-enabled health care practices into hospitals across the province.

Pathfinder Projects

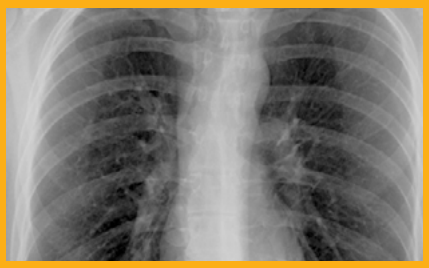
Identified and supported by the Vector Institute, Pathfinder Projects are demonstrable, small-scale efforts that serve as case studies for tackling health care challenges using AI.

EARLY WARNING SYSTEM FOR GENERAL INTERNAL MEDICINE (EWS FOR GIM)

Supporting St. Michael's Hospital in Toronto, EWS for GIM can help predict when patients in the GIM unit will need to be transferred to the intensive care unit.

ARTEMIS

Already in the pilot stage at Southlake Regional Health Centre and McMaster Children's Hospital, the project deploys AI in the NICU to improve clinical decision making for neonatal infants, with a focus on early diagnosis of sepsis.



CORAL REVIEW

A collaboration with Kimia Lab at the University of Waterloo and University Health Network (UHN), this project integrates AI into UHN's existing peer-review system to augment clinicians' capability to review and evaluate x-ray images.

MEDLY

Working with University Health Network (UHN), this project seeks to develop a home-based early warning system for signs of heart failure.

TICK IDENTIFICATION TO COMBAT LYME DISEASE

Working in collaboration with Public Health Ontario, the goal of this project is to create an AI-enabled smartphone app that helps Ontarians identify tick species that potentially carry Lyme Disease and actions they should take to prevent the spread of the disease.

Health Artificial Intelligence & Data Analysis Platform (HAIDAP)

The HAIDAP is a secure high-performance computing environment established through a collaboration between the Vector Institute, ICES, and HPC4Health at The Hospital for Sick Children. The HADIAP provides researchers with access to de-identified health data and has the computational power needed for researchers to develop AI models for the purpose of improving the health system and health outcomes.

Projects using the HAIDAP are already producing results:

- Anna Goldenberg, heptologist Mamatha Bhat, and machine learning researcher Soren Sarvestany developed and tested a machine learning model capable of flagging patients with cirrhosis before the onset of fatal complications. The model is both viable and cost-effective while outperforming existing screening methods, thereby allowing for faster diagnosis and care.
- Working on the HAIDAP, Quaid Morris and graduate student Haoran Zhang developed a natural language processing model using clinical notes from electronic medical records (EMRs). The model more accurately predicts patients whose health care needs are likely to go from low-cost to high-cost in the span of a year. The model can flag patients, allowing earlier intervention by family physicians.
- Vector Faculty Affiliate, Laura Rosella, and master's student, Mathieu Ravaut, are running a deep learning model that they anticipate will lead to the identification of multiple types of diabetes, thereby improving individualized health care and saving the health system significant costs. With the installation of a second tranche of hardware in the HAIDAP, they are seeing great progress in the project's second stage.

"With the new hardware installed in the HAIDAP, the difference is night and day for my project. I can efficiently run my model using much more data, have multiple jobs running in parallel, and have not run into any storage issues so far."

– Mathieu Ravaut, HAIDAP user, Student

Looking Ahead

Vector will continue on a trajectory of rapid growth and deepening impact as we build a research institute that ranks among the world's best, translating research advancements into value for business and society.

Vector will continue to deliver on its mandate to provide training and create a pipeline of post-secondary graduates and interns to support Canadian industry and institutions in becoming best-in-class at the use of AI.

New physical space is needed to accommodate Vector's growing community of researchers and practitioners and ambitious plank of programs as new Faculty Members, Faculty Affiliates, and graduate researchers are brought in to push research forward and help to train the next generation of top AI talent.

As Vector's capacity grows so too will its ability to help industry sponsors realize the potential of AI for their companies. We are creating a professional development certificate course for industry practitioners and progress will continue on consortium projects that help sponsor companies adopt AI faster. We continue to find new high-impact ways to help startups and scaleups with AI-specific challenges. Vector will also continue refining and enhancing its workforce development programs, keeping the foot on the gas on efforts to recruit top researchers.

To unleash AI's transformative potential and enhance economic competitiveness in Ontario, Vector will continue to provide leadership in the province's AI-ecosystem, offering supports to increase the number of local companies adopting AI and hiring skilled talent. Vector's role as facilitator and convener will continue to be an asset as it seeks to combine strengths across Toronto's innovation ecosystem by bringing together post-secondary and research institutions, governments, startups, scaleups, incubators, accelerators, and venture capitalists.

The Vector Institute's work extends well beyond the research lab. Members of the Vector community are working hard to enable AI implementation in a number of real-world settings, particularly in the health field. Work in this area, in terms of research, application, and access to data, will gain momentum as Vector sets new multi-year strategic objectives.

At the same time, Vector is mindful of the broader societal impacts of AI. Vector and its community of both researchers and professional staff are actively engaging in conversations on how business and society can reap the benefits of AI and machine learning while mitigating the risks that it can introduce. The creation of the Schwartz Reisman Institute for Technology and Society and Vector's future co-location with it will ensure that the societal impacts of AI are top of mind in all of Vector's work.

Just two years into its mandate, Vector's accomplishments should not be understated. But as the race to be the world's AI leader shifts into top gear, its work is only just beginning. Nations and organizations are stepping up their efforts, and so are we. Vector will continue to build on the milestones from the past twelve months, which have set the stage for the next 12 months and beyond.

Financials

STATEMENT OF OPERATIONS

March 31	2019	2018
Revenue		
Government grants		
Province of Ontario	$ 9,158,460	$ 4,783,159
Federal Government	5,817,138	2,000,000
Industry partners	12,520,983	7,749,985
Amortization of deferred capital contributions	1,390,606	357,851
Investment income	316,329	33,709
Fees for service	200,728	-
Materials acceleration project	125,838	-
	29,530,082	14,924,704
Expenses		
Research and education (Note 8)	5,936,770	2,414,693
Industry skills training (Note 8)	602,951	53,467
Technology adoption (Note 8)	2,324,866	432,839
Business acceleration	1,500,000	1,500,000
General and administration (Note 8)	3,671,656	1,437,250
RAISE AI	1,382,812	-
Materials acceleration project	125,838	-
Employee loans accretion expense (Note 2)	121,891	-
Amortization	1,390,606	357,851
	17,057,390	6,196,100
Excess of revenue over expenditures before one-time expenses	12,472,692	8,728,604
One-time expenses		
Transition costs	-	944,911
Excess of revenue over expenses for the year	$ $ 12,472,692	$ 7,783,693

STATEMENT OF FINANCIAL POSITION

March 31	2019	2018
ASSETS		
Current		
Cash and cash equivalents	$ 59,919,382	$ 38,381,380
Accounts receivable	3,545,872	2,770,302
Current portion of employee loans (Note 2)	194,443	-
HST rebate receivable	262,422	404,875
Prepaid expenses	53,240	70,081
	63,975,359	41,626,638
Employee loans (Note 2)	1,163,666	-
Capital assets (Note 3)	5,897,982	3,179,000
	$ 71,037,007	$ 44,805,638
LIABILITIES AND NET ASSETS		
Current		
Accounts payable and accrued liabilities	$ 3,682,217	$ 2,162,955
Deferred rent	1,209,424	-
Deferred contributions (Note 4)	41,137,062	31,679,990
Deferred capital contributions (Note 5)	4,751,919	3,179,000
	50,780,622	37,021,945
Net Assets		
Unrestricted net assets	20,256,385	7,783,693
	$ 71,037,007	$ 44,805,638

To view the Vector Institute's audited financial statements for the 2018-2019 fiscal year, please visit https://vectorinstitute.ai/

Leadership

MEMBERS AND BOARD OF DIRECTORS

Ed Clark, Chair

Janet Banister

Scott Bonham

Charmaine Dean

Janet L. Ecker

Vivek Goel

Chaviva Hosek

Nadir Mohamed

Michael Serbinis

Terrence Sullivan

PROFESSIONAL TEAM

From commercialization and industry innovation to research programs, academic partnerships, health strategy, and more, Vector boasts an experienced and highly professional team dedicated to carrying out its mission.

LEADERSHIP

Garth Gibson
President and CEO

Gary Burlakoff
Director of Finance

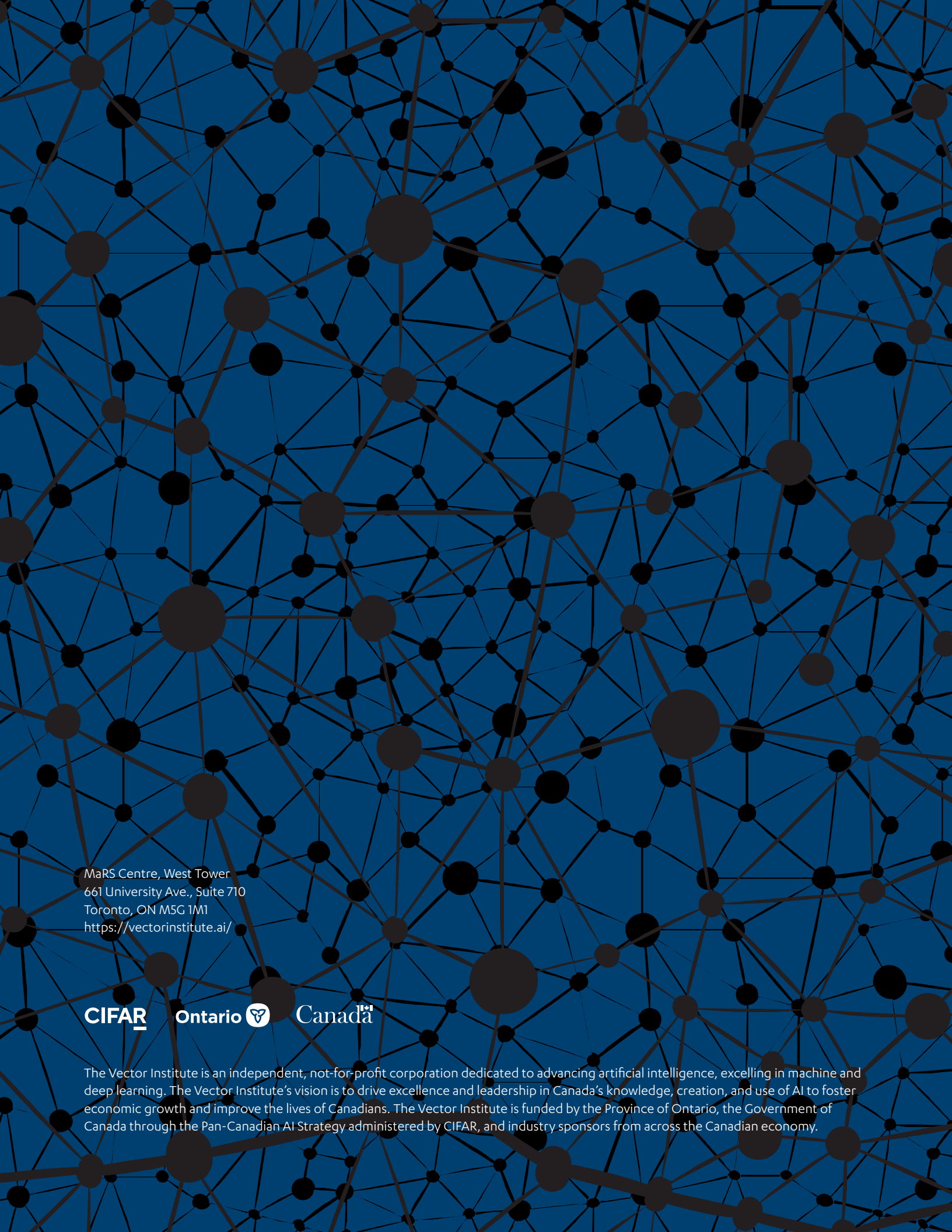
Alison Paprica
VP, Health Strategy and Partnerships

Cameron Schuler
Chief Commercialization Officer and VP, Industry Innovation

Alan Veerman
Chief Operations Officer

Richard Zemmel
Research Director


VECTOR INSTITUTE



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CIFAR Ontario Canada

The Vector Institute is an independent, not-for-profit corporation dedicated to advancing artificial intelligence, excelling in machine and deep learning. The Vector Institute's 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.