



VECTOR INSTITUTE

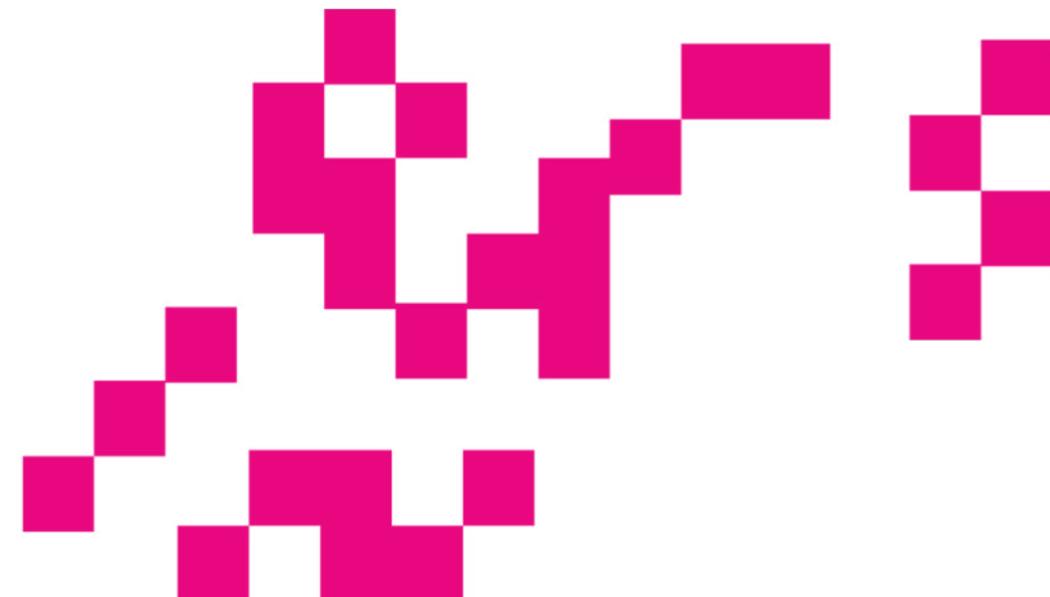


# ANNUAL REPORT 2022 - 2023

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# MESSAGE FROM THE BOARD CHAIR

The commitment to a second phase of the Pan-Canadian Artificial Intelligence Strategy (PCAIS) was confirmation that the Vector Institute's founders' ambitious five-year vision was a resounding success. Vector's role over the next five years will remain focused on ensuring that Canadians and public institutions continue to develop the people, skills, and resources to be best in class at the use of AI.

To sustain Canada's competitive advantage and ensure our economy properly benefits from AI, we need to make sure that Canadian companies have access to both world-leading AI talent and the tools necessary to adopt responsible AI. Over half of Ontario companies have commercialized AI products or services or use AI to deliver or sell their core products and services. That means about half of all Ontario businesses, particularly the small and medium-sized enterprises (SMEs) that make up the backbone of the province's economy, have yet to leverage AI to grow their business. Now is the time to do it, or these companies face being left behind.

AI can also play a huge role in Canada's health systems, improving the delivery and administration of services as well as patient outcomes to save lives. Vector is already seeing the impact of health AI with models helping physicians to validate diagnoses, anticipate spikes in ER admissions, and optimize nurse staffing. But there is much more to do.

The past year has seen a massive shift in the public perceptions of AI, and the Vector community is all too aware of this change. Reasonable concerns about the rapid development of powerful AI models further legitimize Vector's work to enable researchers who are advancing the responsible development of AI. As the pace of AI development accelerates, learning how to deploy it responsibly and wholly understand its full potential is the best way to guard against its misuse.

To this end, Vector is working with our sponsors, governments, international agencies, and regulators to develop principles and best practices to govern AI development and deployment.

This is a job for which Vector's new President and CEO, Tony Gaffney, is uniquely suited. Last year, Garth Gibson completed his successful five-year term as CEO. During this time, Garth oversaw the transition of the Vector Institute from an idea into a crown jewel of Canada's AI ecosystem. With his steadfast leadership, Vector made significant strides in advancing its mandate – attracting the best global talent focused on research excellence in deep learning and machine learning. On behalf of the Board of Directors, I thank him for his valuable contributions.

With over 20 years of experience as a CEO, Tony is a seasoned executive and corporate director, who brings exceptional transformational leadership, fostering growth in both public and private businesses across multiple industry sectors. In the short time since his appointment, Tony has already demonstrated how his industry experience, working with all segments of the economy, as well as extensive international experiences and in-depth understanding of emerging technologies including AI, will be an important asset to Vector as we leverage AI to create Canadian jobs, help businesses grow, improve health outcomes, and expand the Ontario AI ecosystem.

We are already seeing the many and varied benefits of AI and we stand to see countless more in the year to come. Vector has always recognized the positive role this technology will play in our society. Over the past half-decade, Ontario has put in place the necessary infrastructure to take full advantage, with Vector as its centre. The accomplishments detailed in this report are a testament to those forward-thinking efforts.



**ED CLARK**

Chair of the Board of Directors



# MESSAGE FROM THE PRESIDENT AND CEO

We are facing a historical opportunity in Canada to harness the potential of AI to drive economic growth that carries with it a moral responsibility to improve social outcomes.

Being a part of this globally recognized AI institute, at this moment in time, is a privilege.

Vector has played a key role in building Canada's research excellence and global leadership in AI. Over the past year, Vector has made great strides in collaboration with academia and industry, enabling Canadian businesses and public institutions to be better at using AI than their counterparts around the world.

AI is at a crucial inflection point: AI adoption, including generative AI, is accelerating at an unprecedented pace. This moment puts Vector in a unique situation: we are a globally-renowned AI institute empowering researchers, businesses, and governments, all of whom have placed their trust in us to deliver value through AI.

The Vector community has spent years researching neural networks, deep learning, foundation models, and natural language processing (NLP), all of which enable large language models (LLMs) like ChatGPT. This research experience positions the Vector Institute well to support our community in navigating a rapidly changing environment.

As you will read in this Annual Report, Vector is advancing the research, applied knowledge, and talent necessary to maintain the confidence of governments, companies, and the public-at-large in AI adoption. Vector is also supporting

Canada's Global Innovation Clusters and helping startups grow to become Canadian-based global leaders by fostering the AI talent they need to scale their operations.

Vector continues to attract the world's best AI talent. Our community of AI researchers drives leading-edge research, which is regularly published in prestigious peer-reviewed journals and recognized at premier academic conferences globally. Meanwhile, Vector's AI Engineering team and our partner organizations apply that same research to real-world opportunities and issues, delivering value at scale while ensuring that AI is developed and deployed with safety and privacy top-of-mind.

There is enormous potential for Canadian businesses leveraging AI to become more efficient and globally competitive. Over the past year, Vector is helping companies realize these objectives. For example, FastLane, Vector's program to help SMEs leverage AI, now counts more than 175 companies as clients, an astounding number for a program that was launched just 18 months ago.

Meanwhile in the health sector, the strategic deployment of AI has been proven to reduce wait times, increase capacity, and save lives. Through SmartHealth, in collaboration with the Government of Ontario, we are helping improve the efficiency of the province's health system, which is providing Ontarians with better care.

And Vector continues to support cutting-edge research driving AI innovation and building a

talent pipeline that both companies and institutions need to support adoption at an ever-broader scale.

As with any great technological leap forward, the great promises of AI are paired with risk. From its inception, Vector has shared a strong commitment to developing AI that is both safe and trustworthy. As the pace of AI development accelerates, policy makers and AI experts around the world are seeking to develop shared guardrails to help guide future AI development.

To this end, Vector included Bill C-27, which includes the Artificial Intelligence and Data Act (AIDA), as a topic in our fall 2022 [Managing AI Risk](#) project that included representatives from regulators, governments, and companies both large and small. While work progresses both in Canada and internationally on policy, legislation, and regulation, we encourage organizations to focus on [established best practices](#) as they adopt AI into their businesses.

The months that followed the end of our fiscal year suggest that Canadian AI will play an even more prominent role: interest in AI trust principles is now an active topic among Canadian companies; generative AI is now mainstream; and there are worrying signs that Canadian investment in generative AI lags behind global competitors.

We are grateful for the trust placed in Vector by all of our partners and supporters, including the governments of Canada and Ontario, allowing the Vector community to continue to bring

its collective experience to bear on these AI opportunities and challenges.

Vector and our community are well-positioned to harness the full potential of AI. Together with our partners, we can leverage the expertise and capabilities that we've built to drive positive societal change and ensure that the adoption of AI is undertaken responsibly and to the benefit of all Canadians.

This opportunity and responsibility compose a combination that I couldn't be more excited to be leading as Vector works to shape the future of AI in Canada and the world.



**TONY GAFFNEY**  
President and CEO



# VECTOR'S VISION AND MISSION

## 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.

The Vector Institute is funded by the Government of Canada, the Government of Ontario, and leading industry sponsors from across the Canadian economy.

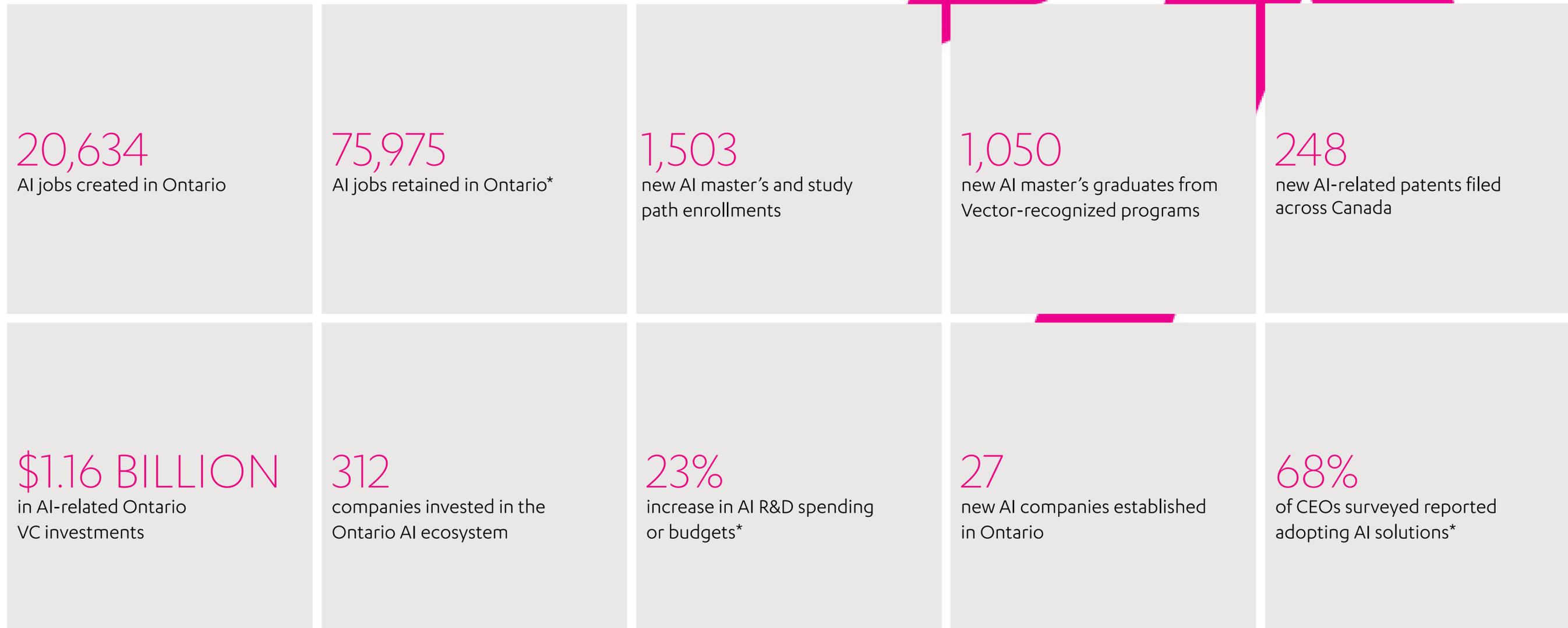


# ONTARIO'S VIBRANT AI ECOSYSTEM

The Vector Institute, in collaboration with Deloitte Canada, produces annual snapshots of the Ontario AI ecosystem, revealing its continued strength and role in nurturing top AI talent.

## HIGHLIGHTS OF ONTARIO'S AI ECOSYSTEM

More Ontario data will be available soon on the [Vector Institute website](#).



\*In this report, Deloitte refined the methodology to improve accuracy of this calculation as well as validated it against other external data sources.

# INDUSTRY INNOVATION

Vector plays a crucial role in empowering businesses across sectors and at all stages of AI adoption to acquire the expertise, frameworks, and skilled workforce they need to innovate and stay competitive.

## VECTOR'S INDUSTRY SPONSORS

- 1 new industry sponsor joined
- 9 Platinum sponsors
- 19 Gold sponsors
- 2 Silver sponsors
- 30 total industry-leading enterprises

## VECTOR CONNECTS ONTARIO TO THE GLOBAL AI ECOSYSTEM WITH A NEW INDUSTRY SPONSOR



The new partnership allows KT Corporation to grow ties within the Ontario and global AI ecosystem as it works towards building a new AI lab in Ontario.

|| KT is delighted to be a sponsor company of Vector Institute, one of the world's top AI research institutes. Through this partnership, KT expects to accelerate its expansion into the global market based on digital platforms. KT plans to apply the latest AI technology to KT AI services through collaborative R&D with the Vector Institute and strengthen employees' AI capabilities by Vector Institute's education programs. ||

-Soonmin Bae, Head of AI2XL research institute, KT

# INDUSTRY SPONSORS

As of March 31, 2023

Partnering with Vector empowers our industry sponsors to tap into a wealth of AI expertise and resources. They gain access to a dynamic sandbox environment where they can safely explore new AI techniques, and become part of a vibrant AI talent ecosystem that is responsibly driving innovation. By joining forces, we're contributing to the growth of businesses and making a meaningful impact on the economic landscape of Ontario.

-Cameron Schuler, Chief Commercialization Office and VP, Industry Innovation, Vector Institute

## PLATINUM

BMO Financial Group\*  
Google\*  
Loblaw Companies Ltd.\*  
NVIDIA\*  
RBC\*  
Scotiabank\*  
Shopify Inc.\*  
TD Bank Group\*  
Thomson Reuters\*

## GOLD

Accenture\*  
Air Canada\*  
Bell Canada  
Boehringer Ingelheim (Canada) Ltd.  
Canadian Tire Corporation, Ltd.  
CIBC\*  
CN\*  
Deloitte Canada\*  
EY Canada\*  
Georgian\*  
KPMG Canada\*  
KT Corporation  
Magna International\*  
OMERS  
PwC Canada\*  
Roche Canada  
Sun Life Financial\*  
TELUS\*  
Thales Canada\*

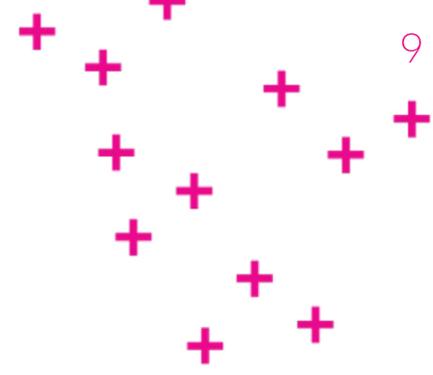
## SILVER

EllisDon Corporation\*  
Linamar Corporation\*

## BRONZE

Ada  
ALS GoldSpot Discoveries Ltd.  
AltaML  
Avidbots  
BenchSci  
Blue J  
Canvass Analytics Inc.  
Clearpath\*  
Cohere  
Cyclica  
Darwin AI  
Deep Genomics\*  
FreshBooks\*  
Integrate.ai\*  
Layer 6\*  
League  
MindBridge Analytics Inc.  
Private AI  
Riskfuel  
Shakudo  
Signal 1  
Stradigi AI  
Surgical Safety Technologies  
TealBook  
Troj.AI  
Wysdom AI

\*Founding sponsors



# SPOTLIGHT ON FASTLANE PROGRAM

Introduced in December 2021, Vector’s FastLane program helps Canadian SMEs embrace AI or expand their current AI capabilities. The program offers targeted and cost-effective solutions to implement AI, enabling FastLane businesses to better compete. Through tailored workshops, events, and specialized programming, the program facilitates rapid AI business transformation while bolstering Ontario’s AI talent pool.



175

SMES ARE PART OF THE FASTLANE PROGRAM



98

SMES JOINED IN 2022-23



+20

EVENTS AND WORKSHOPS DEDICATED TO PROFESSIONAL DEVELOPMENT, TALENT ADVISORY, AND AI COMMERCIALIZATION INSIGHTS WITH +750 PARTICIPANTS

## FASTLANE APPLIED PROJECTS

FastLane Applied Projects is a four-month immersive program designed to support SME innovation by tapping into emerging AI talent and Vector’s expert community of AI practitioners. Participating companies can leverage Vector’s expertise to reduce the time and effort required to develop AI, decrease the cost of recruiting talent, and maximize their chances of success through collaboration with our AI Engineering technical experts.



“The program exceeded my expectations in two ways. One: the quality of the work was really high and there was a lot of value created by the [machine learning associate’s] (MLA’s) in their work term with us, and two: we ended up hiring both of the MLA’s who worked with us, so if there was any proof point that this was a good use of time and resources for everybody all-around, I think hiring the two people you work with for the extended interview period is probably that, so we were exceedingly pleased with how the program went and the outcomes.”

-Morgan Hayduk, Co-founder and co-CEO, Beatdapp

# SPOTLIGHT

## A.I. VALI

A.I. Vali's five-year journey from idea to clinical trial for AIDREA, an AI-powered cancer detection device, required the Toronto-based startup to develop a new technology built to meet the health sector's strict technical and regulatory standards especially around patient privacy. Getting sufficient data without needing hospitals to share it broadly required an advanced AI solution. To find it, A.I. Vali turned to Vector.

Through Vector's FastLane Program, A.I. Vali learned about Vector's Privacy Enhancing Techniques bootcamp, which focused on cutting-edge methods for training models while adhering to strict privacy requirements. For the A.I. Vali team, it was a revelation.



These privacy enhancing techniques are now being embedded in AIDREA as the company works towards ISO certification, Health Canada approval, and a US Food and Drug Administration clinical trial.

For Azar Azad, co-founder and CEO of A.I. Vali, even more exciting than being on the cusp of AI commercialization is the possibility of improving both the work of clinicians and the health of patients. "That has an impact on the entire health economy – for the hospital, the health system, for the patient's quality of life, and for the cost of patient management."

**|| We were stuck with a major problem, and we needed a reliable solution. Our collaboration with Vector has completely shaped our approach to the next steps in regulatory, branding, and product as a diagnostic tool. ||**

-Azar Azad, co-founder and CEO, A.I. Vali

# LEADING THE WAY IN AI PROGRAMMING

Vector offers a diverse range of professional development programs that empower Canadian enterprises to leverage AI for tangible business benefits. These programs equip enterprises to compete at an international level, excel in their industries, and retain high-calibre talent. With a combination of rigorous technical training, practical application, and guidance from Vector's renowned research faculty, participants gain valuable experience in solving real-world challenges specific to their businesses.



## +6,300

PARTICIPANTS UPSKILLED OR TRAINED IN VECTOR'S PROGRAMMING FOR INDUSTRY SPONSORS AND THE PUBLIC IN 2022-23

## BIAS IN AI FOR SMES

36 PARTICIPANTS IN OVER 4 ITERATIONS OF THE PROGRAM

Canadian SME professionals develop technical skills to shape responsible applications of AI where bias may exclude or disadvantage population segments.

## ENDLESS SUMMER SCHOOL (ESS)

6 ESS SESSIONS WITH 260 PARTICIPANTS

Topics included:

- Sustainable AI
- Trustworthy AI
- Forecasting with Deep Learning
- CVPR 2022 highlights
- NeurIPS 2022 highlights
- Health roundup

## BUSINESS INSIGHTS (VBI)

5 VBI SESSIONS WITH 267 PARTICIPANTS

Topics included:

- AI for sustainability
- Large language models
- AI for recruitment and retention
- Explainable and trustworthy AI
- Identifying use cases for AI

## COMMERCIALIZATION

8 COMMERCIALIZATION SESSIONS WITH 210 PARTICIPANTS

Topics included:

- Creative Destructive Lab info session
- Info session with Entrepreneur First
- Legal considerations on Open Source AI
- Machine learning operations for ML startups
- AI intellectual property workshops
- Approximately 700 participants took part in the 2022 AI Founders Master Class series

## FACE-TO-FACE PROGRAM

19 SESSIONS

Industry sponsors benefit from insights shared by Vector's researchers and AI Engineering experts in one-to-one meetings designed to address highly specific AI challenges.

Topics included:

- Best practices for synthetic data creation and use
- Multilingual natural language processing

# GROWING POTENTIAL THROUGH COLLABORATION: RECENTLY COMPLETED PROJECTS

Vector's collaborative projects provide technical professionals from all sectors with opportunities to work alongside Vector's researchers and industry experts. Project participants gain insights into the practical application of AI models and techniques to drive value within their organizations. Collaborative project themes are carefully selected to align with industry needs and create potential for significant industry impact.



## 10

PROJECTS COMPLETED



## +19,000

HOURS OF KNOWLEDGE  
TRANSFER TO INDUSTRY  
SPONSOR EMPLOYEES



## +800

PARTICIPANTS FROM **91**  
INDUSTRY SPONSORS AND  
PARTNER ORGANIZATIONS



## 13

NEW COLLABORATIONS  
LAUNCHED COVERING  
SUCH TOPICS AS CAUSAL  
INFERENCE, GENERATIVE  
AI, RECOMMENDER  
SYSTEMS, ROBOT PROCESS  
AUTOMATION, AND  
SYNTHETIC DATA

## FORECASTING WITH DEEP LEARNING

Seventeen industry sponsor organizations brought 120 participants to a three-day Deep Learning for Forecasting bootcamp. Each company explored their own use-cases with support from Vector including TELUS' initiative to predict the spread of wildfires to safeguard critical infrastructure and Scotiabank's aim to forecast ATM cash requirements for customer accessibility. Based on the success of this project, a second iteration was run later the same year with 55 participants from 13 additional companies.

## CONVERSATIONAL AI

Companies are keen on using AI to enhance customer service. Vector's conversational AI project collaborated with nine industry sponsors to train models for real-time conversation transcriptions. Vector developed a neural agent to extract valuable information for contact centre agents, improving customer interactions. The project team, including CIBC, KPMG, and PwC, authored a paper presented at the Empirical Methods in Natural Language Processing (EMNLP) 2022 Industry track.

## RECOMMENDER SYSTEMS PROJECT

Eleven partners joined Vector to explore AI techniques that could suggest products to customers. Teams later presented their methodology, experiments, and results demonstrating the practical link between AI research and deployment.

Discover one company's [success from this project](#)

## GENERATIVE AI ROUNDTABLE

Vector invited 36 industry leaders to address the opportunities and risks of generative AI for industry. These roundtable discussions will inform future deliberations on safe AI. [Read more](#)

# SPOTLIGHT ON AI INNOVATORS

WAHI JOINS VECTOR'S FASTLANE PROGRAM TO EMPOWER HOMEBUYERS AND SELLERS WITH AI-DRIVEN INSIGHTS



# Wahi

Wahi, a Toronto-based digital real estate company, wanted to build a realtor recommender system to empower consumers with the knowledge and data necessary to discover the ideal real estate agent that suits their needs. But they lacked the manpower and up-to-date know-how to experiment with different techniques needed to build such a system.

Through Vector's FastLane program, the company was able to learn the latest AI techniques from Vector's AI Engineering team. Now, Wahi is exploring new algorithms to better serve their customers so that individuals looking to buy or sell homes in Ontario now have the opportunity to locate the most suitable real estate agents for their specific location and property type. They can easily compare fees, services, realtor profiles, statistics, and even receive personal introductions to ensure they find the perfect match for their needs.

# RESEARCH AND EDUCATION

## VECTOR RESEARCHERS ADVANCE DISCOVERIES IN AI

The Vector Institute is a key player in bringing AI talent to Ontario and Canada. Since 2017, Vector has grown from a small group of founding faculty to a thriving community of over 700 researchers who are responsibly advancing deep learning and machine learning more broadly to make a positive impact on the lives of Canadians.

Vector's commitment to nurturing our community of AI researchers remains strong.

Vector researchers are intensifying investments in areas of existing AI strength, such as health, life sciences, and AI safety, while also moving into new strategic areas like AI for Science and our growing expertise in foundation models.

Everyone who joins Vector's AI community has access to a multitude of opportunities. In addition to many academic pathways, they can also collaborate with some of Canada's leading companies on AI-powered innovation that will contribute to future economic growth or choose to establish their own businesses as entrepreneurs.



# DISCOVER VECTOR'S WORLD-CLASS AI RESEARCH COMMUNITY

Through the recruitment of exceptional researchers, Vector is building a community of global AI experts who are conscientiously progressing AI and machine learning. Together, we are driving advancements that are shaping the future of AI and maintaining Canada's reputation as a leading hub for AI research.

702 members of the Vector research community, comprising:

- 41 Faculty Members including 38 Canada CIFAR AI Chairs
- 102 Faculty Affiliates
- 57 Postdoctoral Fellows
- 451 Graduate Researchers
- 51 Undergraduates

## VECTOR POSTDOCTORAL FELLOWS

21 Postdoctoral Fellows were employed by the Vector Institute in 2022-23

The Postdoctoral Fellow program plays a vital role in driving academic research, innovation, and interdisciplinary collaboration, and it serves as a key initiative in attracting and retaining the world's top AI researchers in Canada.

This program also supports researchers in pursuing future pathways in either academic or industrial roles. Our early-career researchers are supported in conducting research, publishing at international conferences, and enriching both the academic community and reputation of the Vector Institute.

Matteo Aldeghi  
Elham Bagheri  
Franziska Boenisch  
Rob Brekelmans  
Leonardo Cotta  
Felix Dangel  
Adam Dziedzic  
Elahe Ghalebi  
Gavia Gray  
Stefan Heinen  
Agustinus Kristiadi

Scott Lowe  
Kirill Neklyudov  
James Requeima  
Roei Schuster  
Soroosh Shahtalebi  
Suhail Sherif  
Ilya Shumailov  
Matthew Spellings  
Sriram Ganapathi Subramanian  
SiQi Zhou



# VECTOR INSTITUTE FACULTY MEMBERS

MANY FACULTY MEMBERS ARE ALSO CANADA CIFAR AI CHAIRS,  
WITH THE EXCEPTION OF THOSE MARKED WITH AN ASTERISK.

**Alán Aspuru-Guzik**

**Jimmy Ba**

**Shai Ben-David**

**Michael Brudno**

**Juan Felipe Carrasquilla Álvarez**

**Jeff Clune**

**Wenhu Chen**

**David Duvenaud**

**Murat Erdogdu**

**Amir-massoud Farahmand**

**Sanja Fidler**

**David Fleet**

**Brendan Frey\***

**Animesh Garg**

**Marzyeh Ghassemi**

**Rahul G. Krishnan**

**Roger Grosse**

**Gillian Hadfield**

**Xi He**

**Gautam Kamath**

**Chris Maddison**

**Alireza Makhzani**

**Sheila McIlraith**

**Yalda Mohsenzadeh\***

**Parvin Mousavi**

**Sageev Oore**

**Nicolas Papernot**

**Gennady Pekhimenko**

**Toniann Pitassi**

**Pascal Poupart**

**Daniel Roy**

**Frank Rudzicz**

**Angela Schoellig**

**Leonid Sigal**

**Vered Shwartz**

**Graham Taylor**

**Raquel Urtasun\***

**Anatole von Lilienfeld**

**Bo Wang**

**Yaoliang Yu**

**Richard Zemel**

## MEET OUR NEWEST FACULTY MEMBERS

**Wenhu Chen**

**Gillian Hadfield**

**Xi He**

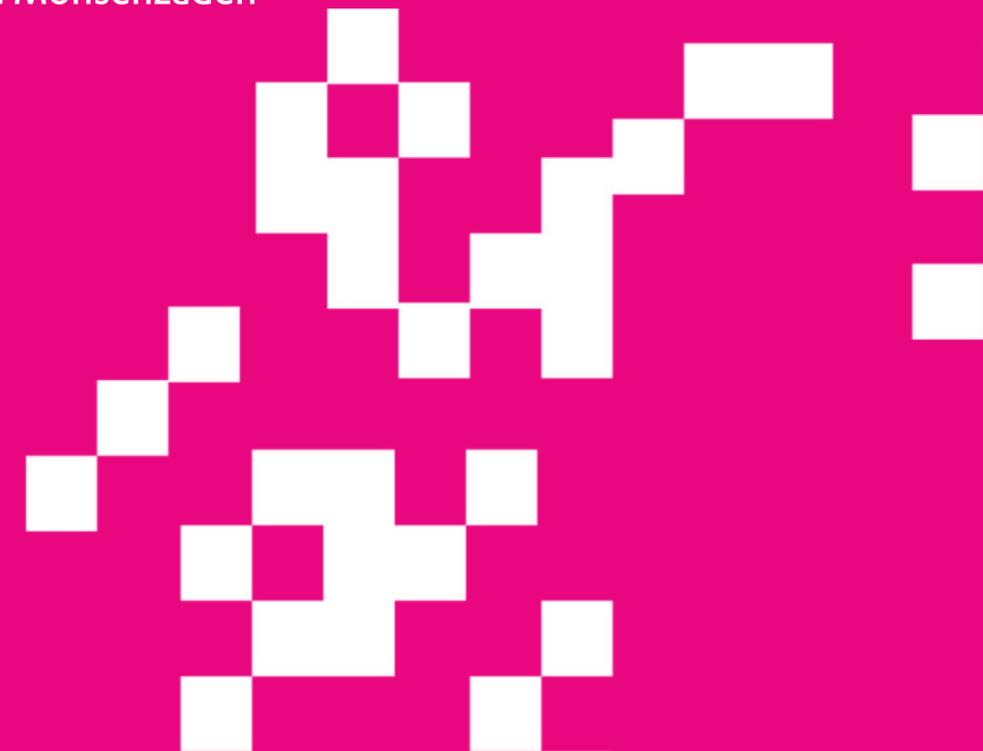
**Gautam Kamath**

**Anatole von Lilienfeld**

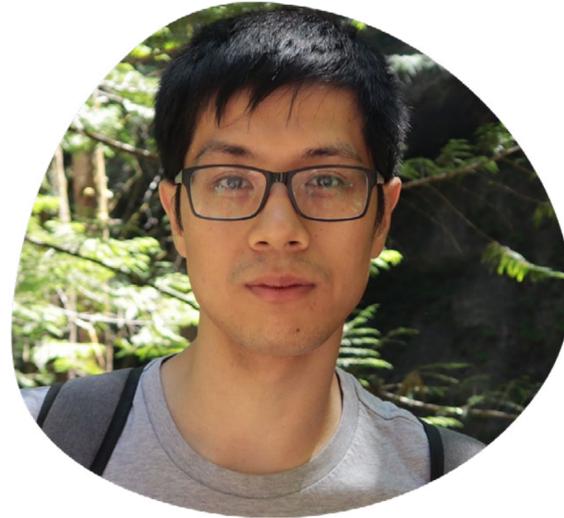
**Parvin Mousavi**

**Vered Shwartz**

**Yalda Mohsenzadeh**



# SPOTLIGHT ON NEWEST FACULTY MEMBERS



## WENHUI CHEN

Wenhui Chen is an Assistant Professor at the David R. Cheriton School of Computer Science in the Faculty of Mathematics at the University of Waterloo, and a Canada CIFAR AI Chair.

He is a leader in natural language processing (NLP), was recognized as the top reviewer in NeurIPS 2019, and received the Workshop on Applications for Computer Vision best student paper honorable mention in 2021. His research interests include NLP, deep learning, and knowledge representation.



## GILLIAN HADFIELD

Gillian Hadfield is the Director of the Schwartz Reisman Institute for Technology and Society, the Schwartz Reisman Chair in Technology and Society, Professor of law and of strategic management at the University of Toronto, a senior policy advisor at OpenAI, and a Canada CIFAR AI Chair.

Her current research is focused on innovative design for legal and regulatory systems for AI and other complex global technologies; computational models of human normative systems; and working with machine learning researchers to build ML systems that understand and respond to human norms.



## XI HE

Xi He is an Assistant Professor at the David R. Cheriton School of Computer Science in the Faculty of Mathematics at the University of Waterloo, and a Canada CIFAR AI Chair.

Her research focuses on the areas of privacy and security for big data, including the development of usable and trustworthy tools for data exploration and machine learning with provable security and privacy (S&P) guarantees. Considering S&P as a first-class citizen in system and algorithm design, she has demonstrated new optimization opportunities for these S&P-aware database systems and machine learning tools.



## GAUTAM KAMATH

Kamath is an Assistant Professor at the David R. Cheriton School of Computer Science in the Faculty of Mathematics at the University of Waterloo and a Canada CIFAR AI Chair.

His research revitalizes the toolkits needed in the modern data era, addressing fundamental problems in the realms of robustness and data privacy, by developing guarantees for trustworthy and reliable machine learning and statistics.

## SPOTLIGHT ON NEWEST FACULTY MEMBERS



### YALDA MOHSENZADEH

Yalda Mohsenzadeh is an Assistant Professor in the Department of Computer Science and Western Institute for Neuroscience at the University of Western Ontario.

Her research is interdisciplinary, spanning computer vision, deep learning, machine learning, and their application in cognitive computational neuroscience and medical imaging.



### PARVIN MOUSAVI

Parvin Mousavi is a Professor of Computer Science, Medicine, Pathology and Biomedical and Molecular Sciences at Queen's University, a member of the Royal Society of Canada, College of New Scholars and a Canada CIFAR AI Chair.

Her research focus is on developing and leveraging machine learning in computer-assisted medical interventions and precision medicine, and contributing to the societal impact of AI on the global community.



### VERED SHWARTZ

Vered Shwartz is an Assistant Professor of Computer Science at the University of British Columbia and a Canada CIFAR AI Chair.

Her research interests include common sense reasoning, computational semantics and pragmatics, and multi-word expressions.



### ANATOLE VON LILIENFELD

Anatole is a Professor at the University of Toronto and holds the Clark Chair of Advanced Materials at the Vector Institute and the University of Toronto and a Canada CIFAR AI Chair.

His current research interests include chemical compound space, quantum machine learning, computational materials design and discovery, experimental design, and chemical reactions.

# VECTOR FACULTY AFFILIATES

By uniting prominent researchers from across Ontario, the Vector Faculty Affiliate Program expands the scope of expertise within the community and fosters interdisciplinary collaboration in AI and its related fields, such as computer science and engineering, fueling innovation in crucial application domains.

## Meet our Faculty Affiliates



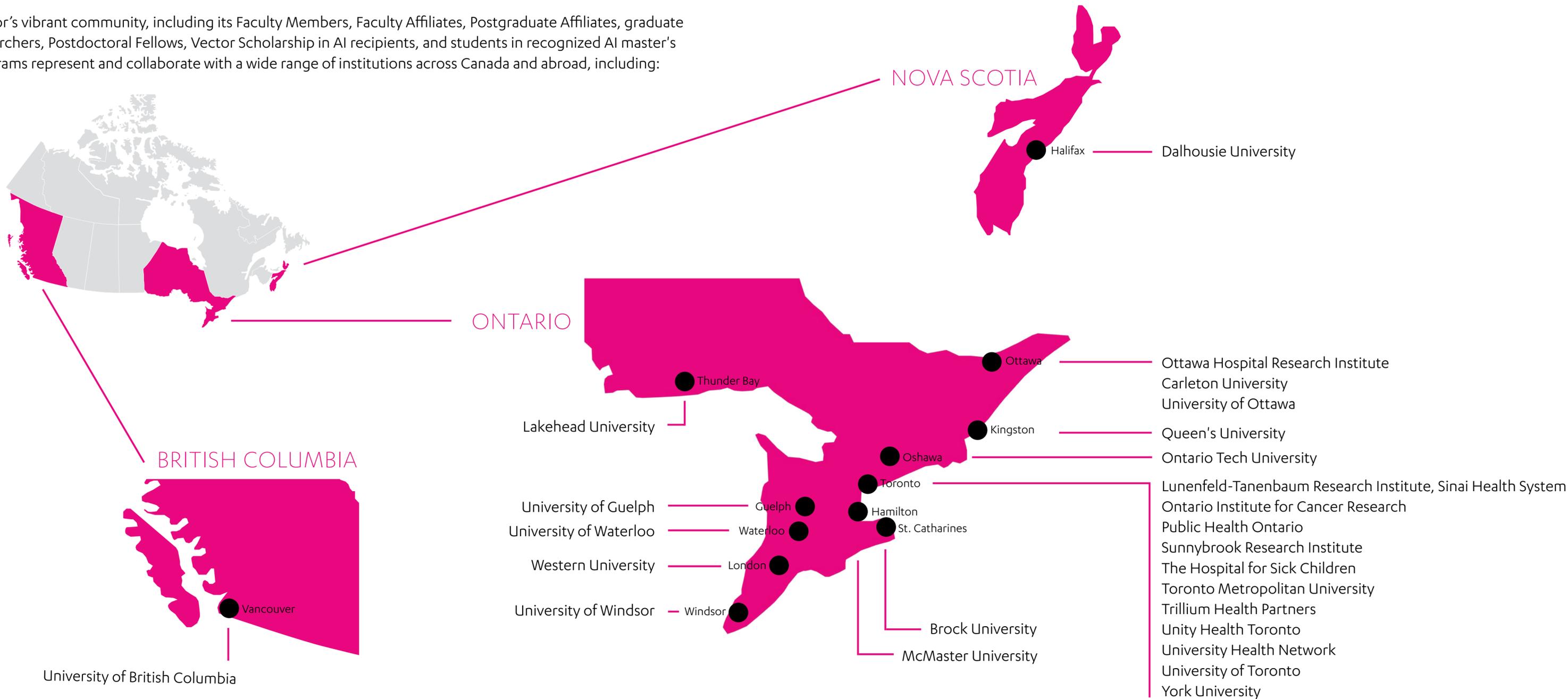
Photo credit: UofT

## THE POWER OF INTERDISCIPLINARY COLLABORATION: SCOTT SANNER, VECTOR FACULTY AFFILIATE

Scott Sanner, Associate Professor in Industrial Engineering, University of Toronto, spent years trying to find recommendation subgroups in companies across Toronto and Ontario to no avail. Through his position as a Vector Faculty Affiliate, Sanner was asked to join Vector's Recommender Systems Project as an academic advisor in summer 2022. Sanner says the project is a great example of an industry-research interdisciplinary partnership where common problems were identified allowing groups to learn from each other. "The project required Vector to have the technical and organizational knowledge, business contacts, and skills to recognize common problems. This is something that I would not have expected to emerge from industry or academia alone. It was a win-win-win for everyone."

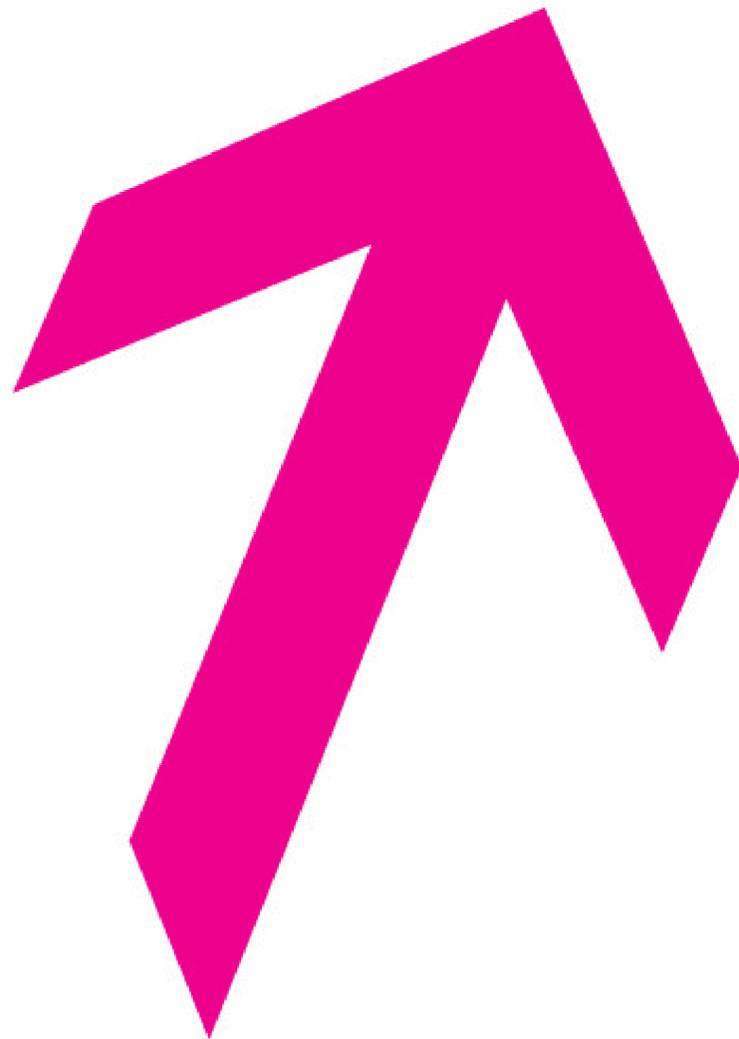
# VECTOR AFFILIATED INSTITUTIONS

Vector's vibrant community, including its Faculty Members, Faculty Affiliates, Postgraduate Affiliates, graduate researchers, Postdoctoral Fellows, Vector Scholarship in AI recipients, and students in recognized AI master's programs represent and collaborate with a wide range of institutions across Canada and abroad, including:



# FUELING AI INNOVATION WITH SHARED RESEARCH BREAKTHROUGHS

The Vector Institute's research community works at the forefront of AI innovation. With numerous projects and themes that are both timely and globally impactful, these projects push the boundaries of scientific discovery and practical application, leading to improved economic growth, enhanced health outcomes, and positive societal transformations.



## RESEARCH IN ACTION

### NEW AI FRAMEWORK HELPS MAP AND MANAGE INVASIVE MUSSEL SPECIES IN CANADA'S LAKES

Vector PhD candidate Angus Galloway and Vector Research Director Graham Taylor, Professor of Engineering at the University of Guelph, used computer vision to identify and map mussels in lake bed images, which is key to reducing harmful impacts on natural ecosystems and critical infrastructure. The framework also opens the door for further environmental applications.

### VECTOR FACULTY MEMBER JEFF CLUNE'S QUEST TO CREATE OPEN-ENDED AI SYSTEMS

Vector Faculty Member Jeff Clune, Associate Professor, Department of Computer Science, Faculty of Science, University of British Columbia, helped to design the [POET](#) system, which creates its own challenges and then solves them in an "open-ended stream of learning and innovation." Such algorithms are part of an even more ambitious goal: AI that endlessly improves itself.

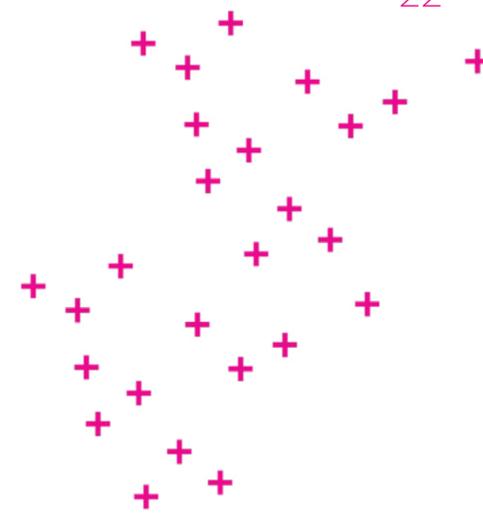
### Research Symposium 2022-23

The 2022-23 Research Symposium brought together over 200 researchers, including some of the world-greatest minds in AI, to share their latest leading-edge work and facilitate collaboration. This past year's event was the first large-scale in-person gathering of Vector's research community since the COVID-19 pandemic.

During the Symposium, Vector Faculty Member Vered Shwartz gave a talk entitled Incorporating Commonsense Reasoning into NLP Models. "NLP has made a lot of progress over the last few years," Shwartz said after her presentation. "But it still lacks common sense reasoning, which is required to understand language."

**"The Research Symposium highlights the work of our AI researchers, connecting them with Vector's Faculty Members and Faculty Affiliates," says Vector's Research Director Graham Taylor. "It's an important touchpoint for the entire Vector community, a communications development opportunity for trainees, and an AI networking opportunity across Canada."**

[Watch highlights from the 2022-23 Research Symposium](#)



# RESEARCH AWARDS AND ACHIEVEMENTS

Over the past 12 months, many of the remarkable contributions to AI and ML made by members of Vector’s research community were recognized and celebrated. Notable highlights include:

## Vector researchers win top honours at NeurIPS 2022

Two Vector papers won top honours at the 2022 NeurIPS conference. Photorealistic Text-to-Image Diffusion Models with Deep Language Understanding, co-authored by Vector Faculty Member David Fleet, was awarded an Outstanding Paper Award. Meanwhile, ImageNet Classification with Deep Convolutional Neural Networks, a 2012 paper co-authored by Vector’s Chief Scientific advisor Geoffrey Hinton, Alex Krizhevsky, and Ilya Sutskever, won the Test of Time award.

[Learn more about the accepted NeurIPS papers and workshops from Vector Faculty Members](#)

## Global reach of Vector researchers and their work

Vector researchers gave presentations and led workshops at many of the top publishing AI conferences this year, including NeurIPS, CVPR, ICLR, and ICML.

**+330** research papers presented at high-impact global conferences and in top ranked journals

**+60** patents

**+230** research talks

**+50** Vector-hosted research events

## FACULTY MEMBERS

Alán Aspuru-Guzik  
John C. Polanyi Award, Canadian Society for Chemistry (CSC), 2022

Amir-massoud Farahmand  
Highlighted Area Chair, ICLR, 2022

Anna Goldenberg  
Woman of Action Award, Israeli Cancer Research Foundation, 2022

Bo Wang  
Gairdner Early Career Investigator Award, 2022

David Fleet  
Outstanding Paper Award, NeurIPS, 2022

Gennady Pekhimenko  
Google Research Scholar, Google, 2022  
ASPLOS 2023 Distinguished Artifact Award, ACM, 2023  
VMware Early Career Faculty Award, VMware, 2022

Gillian Hadfield  
The Bellagio Centre Residency Award, Rockefeller Foundation 2022

Graham Taylor  
Tier 2 Canada Research Chair in Machine Learning

Jimmy Ba  
Sloan Research Fellowship in Computer Science, Alfred P. Sloan Foundation 2022

Leonid Sigal  
Best Paper Award Finalist, CVPR 2022

Nicolas Papernot  
Outstanding Paper Award, ICLR, 2022  
Early Researcher Award, Ministry of Colleges and Universities, 2022  
Oral Paper Award, ICLR, 2023

Rahul G. Krishnan  
Amazon Research Award, Amazon Research, 2023

Sheila McIlraith  
ICAPS Influential Paper Award 2022

Raquel Urtasun  
Longuet-Higgins prize, CVPR 2022

## FACULTY AFFILIATES

Ajay Agrawal  
President’s Impact Award at the University of Toronto, 2023

Alec Jacobson  
Best Paper Award, SIGGRAPH, 2022

Paul David McNicholas  
Dorothy Killam Fellowship, 2023

Sushant Sachdeva  
FCOS 2022 Best Paper award, 2022  
Young Alumni Achiever Award, IIT Bombay 2023

Bhavin Shastri  
iCANX Young Scientist Award, iCANX 2022  
SPIE Early Career Achievement Award, International Society for Optics and Photonics, 2022

# RESEARCH AWARDS AND ACHIEVEMENTS

## TEST OF TIME AWARDS



### SHEILA MCILRAITH, ICAPS INFLUENTIAL PAPER AWARD 2022

Sheila McIlraith was honoured with the ICAPS Influential Paper Award 2022, a prestigious test of time award that recognizes significant and influential papers published at least ten years earlier. Her 2012 paper, Improved Non-deterministic Planning by Exploiting State Relevance, introduced groundbreaking techniques that laid the foundation for the highly regarded project research planner (PRP). The PRP revolutionized the computation of plans, offering remarkable speed improvements compared to previous approaches.

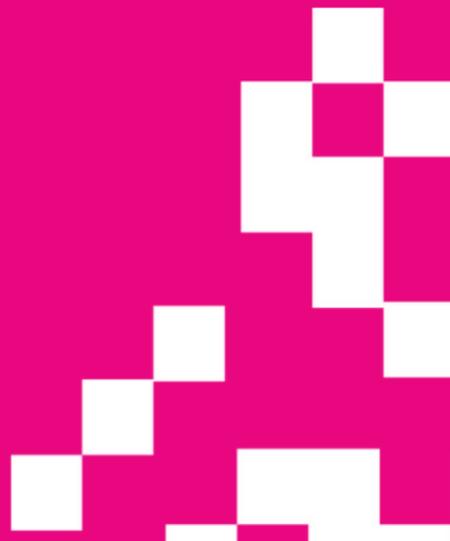
[Learn more](#)



### RAQUEL URTASUN, LONGUET-HIGGINS PRIZE, CVPR 2022

Raquel Urtasun, along with her former students Andreas Geiger and Philip Lenz, received the Longuet-Higgins Prize at CVPR 2022 for their notable work on their paper, Are we ready for Autonomous Driving? The KITTI Vision Benchmark Suite. The Longuet-Higgins Prize, presented during CVPR by the Institute of Electrical and Electronics Engineers' Pattern Analysis and Machine Intelligence Technical Committee, is an esteemed test of time award that acknowledges fundamental contributions with a significant impact on the field of computer vision.

[Learn more](#)



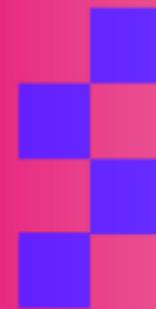
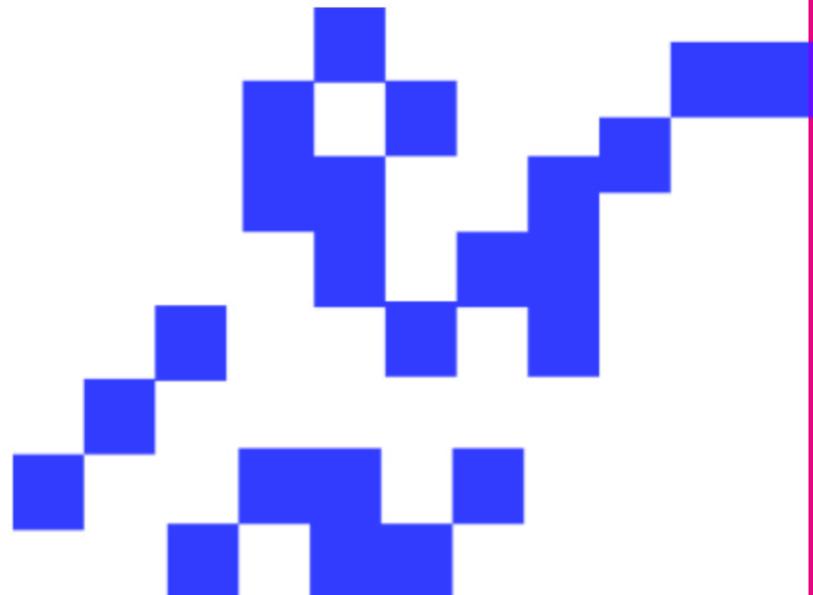
# TALENT AND WORKFORCE DEVELOPMENT

## VECTOR'S CRUCIAL ROLE IN ADVANCING ONTARIO'S ECONOMY

Vector works with both universities and employers to address the increasing demand for AI expertise by creating channels for promising students to access degree programs that cultivate the most sought-after AI skills in industry.

Through Vector's initiatives and experiential learning opportunities, students learn crucial AI technical and job-related competencies, make connections with leading employers, and contribute to the constructive hiring outcomes that are reshaping Ontario's economy.

As of March 31, 2023, more than 1,325 students from Vector-recognized programs and AI study paths, including Vector Institute Scholarship in Artificial Intelligence (VSAI) recipients, have been hired by Ontario employers.



**|| Ontario is a strong player in the field of artificial intelligence, technology, and research, and we are thrilled to see so many new graduates looking to invest their skills and ideas in the province. ||**

-Vic Fedeli, Minister of Economic Development, Job Creation and Trade of Ontario\*

\*Quote source

# BUILDING ONTARIO'S AI WORKFORCE OF THE FUTURE

Vector recognizes AI master's programs and AI-focused curricula at Ontario universities, which are equipping graduates with the top-quality AI skills they'll need for the workplace.

Vector's recognition brings a range of benefits to:

- Leading employers who can confidently hire graduates that have developed essential skills in AI application.
- Students who can access Vector's comprehensive workforce development programs and career support.
- Universities that can receive valuable input from Vector Faculty Members and industry representatives, ensuring the development of relevant AI curriculum and integration of AI across disciplines to meet evolving labour market demands.

Vector works with university partners across Ontario to inform AI curriculum development. Twenty-six AI master's programs have been recognized as delivering the skills and competencies sought by employers hiring AI talent. Since the inception of the Vector-recognized programs in 2018, 92% of graduates from these programs have stayed in Ontario.

Lakehead University

- MSc in Computer Science (Specialization in AI)

Ontario Tech University

- Master of Business Analytics and Artificial Intelligence (MBAI)

Ontario Tech University

- Master of Information Technology Security (Artificial Intelligence in Security Field) (MITS-AIS)

Queen's University

- MSc in Electrical and Computer Engineering (Field of Study in AI)
- MSc in Computer Science (Field of Study in AI)

Queen's University (Smith School of Business)

- Master of Financial Innovation and Technology (MFIT)
- Master of Management Analytics
- Master of Management in Artificial Intelligence

Toronto Metropolitan University

- MEng (AI Concentration)
- MSc in Data Science and Analytics

University of Guelph

- Master of Data Science
- MSc/MASc (Collaborative Specialization in AI)

University of Ottawa

- MEng/MASc in ECE (Applied AI Concentration)
- Master of Computer Science (Applied AI)

University of Toronto

- Master of Health Informatics (MHI)
- Master of Science in Health Policy, Management and Evaluation, Emphasis in Health Systems AI

University of Toronto (Rotman School of Management)

- Master of Management Analytics

University of Waterloo

- Master of Data Science and Artificial Intelligence (MDSAI)
- MMath in Data Science

University of Windsor

- MSc in Computer Science (Concentration in AI)

Western University

- Master of Data Analytics (Specialization in Artificial Intelligence)
- MSc in Computer Science, MEng/MESc in Electrical and Computer Engineering (Collaborative Specialization in AI)
- Collaborative Specialization in Machine Learning in Health and Biomedical Sciences

York University

- MSc in Computer Science (Specialization in AI)

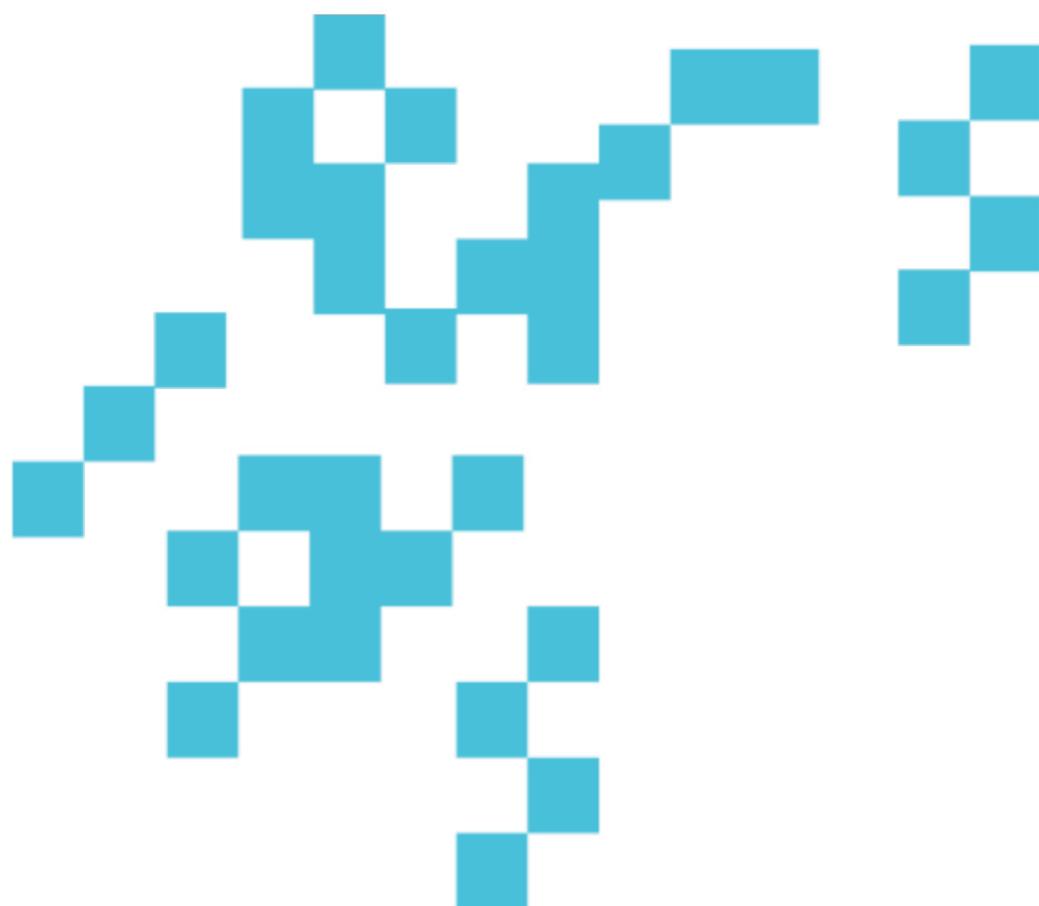
York University (Schulich School of Business)

- Master of Business Analytics
- Master of Management in Artificial Intelligence

# VECTOR SCHOLARSHIPS IN AI DRAW EXCEPTIONAL TALENT TO ONTARIO UNIVERSITIES

Thanks to funding generously provided by the Province of Ontario, Vector Scholarships in AI (VSAI) enable the recruitment of talented and promising students from around the world into AI-related master's programs at universities across Ontario.

Recipients gain unique access to renowned AI researchers, clinicians, and leading industry teams, giving them a competitive advantage in the fast-paced AI landscape. They also benefit from Vector's Digital Talent Hub, specialized career guidance programs, and exclusive AI-focused events, fostering their growth and success in this dynamic field.



110 Scholarships awarded

26 Programs

11 Universities

461 Scholarships awarded since the program launched in 2018

"Just being nominated has given me a great deal of confidence that people have faith in me and that people are interested in [my] work. It's been really exciting to be a part of a community of people...who are interested in the future of AI, especially the ethical use of AI."

-Natasha Rozario, Master of Health Informatics, University of Toronto\*

"The Vector Institute Scholarship in Artificial Intelligence is unique because it is open to graduate students in professional programs in addition to those pursuing research-oriented degrees. Western Science's Master of Data Analytics program is grateful for Vector's recognition of its AI specialty field. The support provided through Vector, including its scholarship program, not only helps us attract top machine learning and artificial intelligence talent to Western, but also provides valuable networking and professional development opportunities for our students to expand their knowledge and build their professional network, helping them prepare for a data science and analytics-focused career."

-Douglas Woolford, Director of Master of Data Analytics, Western University

\*Quote source

# EXPANDING CAREER PATHWAYS THROUGH INTERNSHIPS

## VECTOR'S INTERNSHIP PROGRAMMING

Vector's Research Internship Program is instrumental in expanding the AI ecosystem for advanced research, innovation, industry, and health.

By introducing a new Open Call portal, Vector can efficiently identify top AI talent from Canada and worldwide while aspiring research interns enjoy better access to a rapidly expanding AI ecosystem, and to collaborating with Vector's faculty on novel deep learning and machine learning breakthroughs.

Over the past year, Vector welcomed 29 research interns to the community, providing them with opportunities to work alongside high-profile researchers and gain hands-on research experience. The ability to identify top talent from around the globe is key to both Vector's future success and the advancement of deep learning and machine learning breakthroughs.

Vector also welcomed new research interns as part of the Black & Indigenous Research Intern program, which is specifically designed to build research and expand career pathways in AI for underrepresented groups.

Forty-one Ukrainian interns joined Vector this past year through a Vector-supported summer research program in computer science for students from Ukraine. The University of Toronto and University of Waterloo programs accepted senior undergraduate students (year 3 or higher), graduate students (MSc), and PhD candidates from Ukrainian universities whose studies were affected by the Russian invasion and war in Ukraine.



## APPLIED INTERNSHIPS

62 applied internships in Vector's Applied intern program, working on Vector projects across its Industry Innovation, Health, Research, and AI Engineering teams

"One person's efforts towards Vector's mission (and the Pan-Canadian AI Strategy more broadly) strengthens the ecosystem and the organizations and people within it. I find this kind of big-picture thinking inspiring and it's the lesson that will stick with me the most in any future leadership roles...Throwing yourself into a new role or community can be intimidating, but my experience and the people that I have met during this internship have been truly world-class."

-Sacha Davis, AI Project Management Intern, Fall 2022

# EXPANDING CAREER PATHWAYS THROUGH INTERNSHIPS



In the summer, Mark Thomas joined the Vector community as a research intern in Vector's Black and Indigenous Research Internship program, working with Faculty Member Nicolas Papernot. This experience gave Thomas exposure to both cutting-edge research and an opportunity to contribute to meaningful projects.

During his 2022 internship, Thomas:

- performed a literature review on Byzantine-robust aggregation methods
- implemented an experimental pipeline using PyTorch to train deep neural networks
- analyzed experimental results and prepared figures for publication using pandas and Seaborn

Building on this foundation, Thomas furthered his expertise in ML by enrolling in Vector's [Introduction to Machine Learning for Black & Indigenous Post-Secondary Students](#) course in fall 2022. After successfully completing the course, Thomas secured another research internship opportunity for this coming summer.

Thomas' journey in academia will continue as he begins his Master's degree in Computer Science at the University of Toronto. Recognizing his exceptional talent and potential, Thomas was also awarded a VSAI for the fall of 2023 positioning him well to shape the future of AI.

# ACCELERATING CAREER CONNECTIONS THROUGH CANADA'S MOST EXTENSIVE AI-SPECIFIC JOB PORTAL

Ontario's most exceptional employers and talented individuals are coming together like never before on Vector's Digital Talent Hub, where prominent industry sponsors share AI-focused internships and jobs with an expanding group of AI-proficient talent.

## STEADY GROWTH ON VECTOR'S DIGITAL TALENT HUB:

+3,350

ACTIVE JOB SEEKER PROFILES, UP 36% SINCE LAST YEAR

58

TOP EMPLOYERS USED THE DIGITAL TALENT HUB TO FIND TOP AI-SKILLED TALENT (A TOP EMPLOYER IS DEFINED AS A COMPANY THAT PARTNERS WITH THE VECTOR INSTITUTE)

2,287

JOBS POSTED IN 2022-23

## CONNECTING TOP TALENT AND EMPLOYERS THROUGH VECTOR'S AI SUMMIT AND CAREER FAIR

The annual Vector AI Summit and Career Fair gathers together students pursuing AI programs and Vector alumni to gain insights from industry leaders, practitioners, and researchers. Attendees learn about career opportunities with organizations at the forefront of AI research and adoption, acquire tips for landing their desired jobs, and network with other AI professionals from across Ontario.

+400

GRADUATE STUDENTS AND ALUMNI ATTENDED

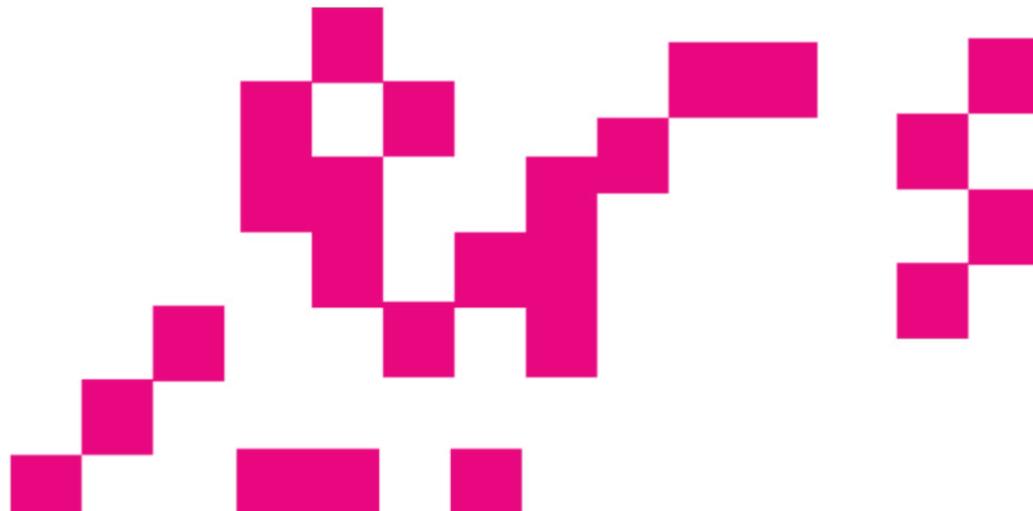
+28

EMPLOYERS ATTENDED

## 12 MONTHS POST-GRADUATION

94% OF GRADUATES FROM VECTOR-RECOGNIZED AI PROGRAMS ARE EMPLOYED OR PURSUING FURTHER EDUCATION IN THE FIELD

91% OF THOSE EMPLOYED HAVE REMAINED IN ONTARIO



# RESEARCH SPOTLIGHT: SAFEGUARDING PRIVACY IN MACHINE LEARNING



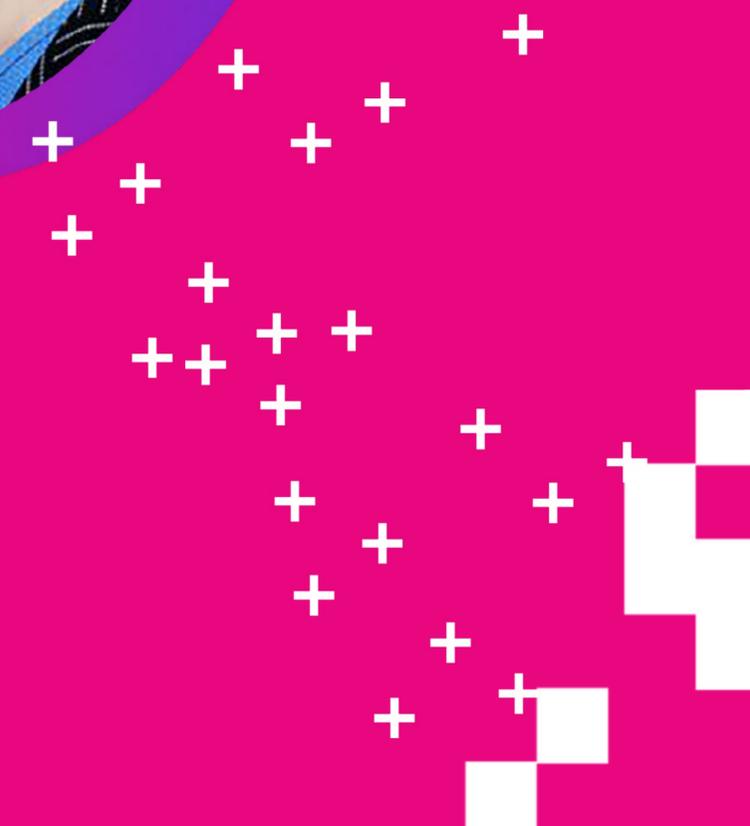
With a focus on understanding privacy risks in trained ML models, Vector Postdoctoral Fellow Franziska Boenisch's work centres on protecting individual users and their data to ensure the trustworthiness and privacy of machine learning (ML) systems.

Her research primarily revolves around differential privacy, a mathematical framework that provides rigorous privacy guarantees. In addition to privacy, Boenisch explores the complex relationship between ML privacy and other critical aspects of trustworthy ML, including robustness, fairness, and biases.

As part of Vector's vibrant community of researchers, Boenisch opened Vector's 2022-23 AI Research Symposium with her talk, "What Trust Model is Needed for Federated Learning to be Private?"

"There is always a severe risk of privacy leakage for the user," she said after the talk. "Even if we protect the federated learning protocol with dedicated techniques, there is still a risk of privacy leakage because the companies or the services deploying the protocol have the upper hand in comparison to the users."

[Learn more about Franziska and her current research](#)



# HEALTH

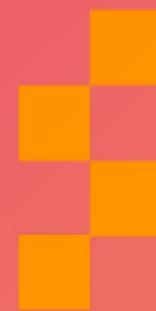
## VECTOR IS ADVANCING RESPONSIBLE AI-DRIVEN HEALTH INNOVATION

Working with partners in the health sector, Vector is facilitating secure and privacy-enabled access to Ontario's diverse de-identified health data, driving advancements in health AI and ML.

This approach enables important discoveries that have the potential to improve health system quality and efficiency, benefiting patients, families, and the sustainability of Ontario's public health system — saving lives and improving outcomes.

Through the Smart Health initiative, Vector combines high-quality, de-identified health data with AI expertise to assist health partners in responsibly applying AI for patient-centred care, greater efficiency, and improved clinical outcomes.

These AI-driven projects are helping improve care for Ontarians, reducing costs for the health system, and improving the lives of patients and their families.



# ENHANCED DATA SHARING PAVES THE WAY FOR HIGH-IMPACT RESEARCH IN HEALTH

Throughout 2022-23, Vector continued to grow new and existing partnerships with hospitals, clinical research institutes, and other health sector collaborators across Ontario.

These partnerships ensure secure and protected access to de-identified health data, resulting in an unparalleled resource that fuels the next wave of insights that will enhance diagnostics, patient care, and overall health system performance.

The growing number of de-identified Ontario clinical and administrative health data sets available to Vector puts its AI practitioners at the forefront of vital investigations across multiple focus areas.



23

ACADEMIC PARTNERSHIPS



10

NEW DATA SHARING AGREEMENTS WITH ONTARIO HOSPITALS AND RESEARCH COLLABORATORS

By unlocking the potential of enhanced data sharing, AI can be used to profoundly impact health care, enhancing Ontarians' quality of life with every new insight.

## ACCELERATING AI AND ML HEALTH APPLIED RESEARCH WITH GEMINI - CANADA'S LARGEST HOSPITAL DATA STUDY

GEMINI is a centralized, rich resource with patient data from over 30 Ontario hospitals that Vector, in partnership with Unity Health Toronto, helped to standardize and optimize for AI and ML discovery. Vector researchers are using this data to conduct many innovative research studies, from evaluating and monitoring ML risk prediction models in clinical settings, to analyzing data using advanced deep learning algorithms, and more.

One area of growing interest is using GEMINI to develop cutting-edge, privacy-enhancing technology.

Privacy is a big concern for health data, especially when sharing data across institutions. To address this, Vector's AI Engineering and Health teams are exploring federated learning (FL), which is a method for applying AI models without the need to centralize data. The teams are using GEMINI to develop and test an open-source library of FL tools which could remove the need to share data in the future - paving the way to securely deploy AI and ML at individual institutions.

# AI-POWERED SOLUTIONS LEAD TO IMPROVED HEALTH OUTCOMES

In 2022-23, Vector's leadership and expertise played a crucial role in enabling the integration of AI within Ontario hospitals and other health organizations.

Collaborations like Vector's proof-of-concept Pathfinder Projects, a series of deployment projects enabled through our Smart Health initiative, show how ML discovery can improve health outcomes and enhance system performance by:

- **Reducing unnecessary hospital visits and more efficiently utilizing health human resources** through AI-enabled tools like Medly
- **Improving quality of care and more efficiently targeting resources** through advancements like CHARTWatch
- **Increasing efficiency in identifying patients and care** through tools like Coral Review

## MEDLY-AI

Medly supports remote management of people living with congestive heart failure, one of the top reasons for hospital admissions across Canada. Health care providers use the app to monitor their patients' physiological vital signs and symptoms. The app then generates alerts when a patient's vital signs fall outside of pre-set boundaries defined by a rules-based algorithm.

A single Medly nurse coordinator can now deliver comprehensive care to up to 200-300 complex chronic patients. This efficiency lightens the load on Ontario's health system while helping individuals receive the personalized support they need.

Medly-AI, an optimized, ML-based version of the Medly algorithm, utilizes the power of retrospective analysis and blood labs to minimize false-positive flags. The tool is undergoing a prospective validation to further reduce false positives and the burden on clinics in investigating erroneous alerts.

Use of the AI-powered Medly tool has already shown a 50% decrease in hospitalizations for patients related to their heart failure and a 24% decrease in hospitalizations for any cause.

[Learn more](#)

## CORAL REVIEW

This AI-enabled tool has the ability to detect pneumothorax, which is a collapsed lung, patients' x-ray images. Acting as a virtual second opinion, it equips physicians with additional insights when reviewing images, improving both diagnostic accuracy and patient care. By helping to identify affected patients faster, physicians can prioritize their care, meaning the people who need the most urgent care can be treated faster.

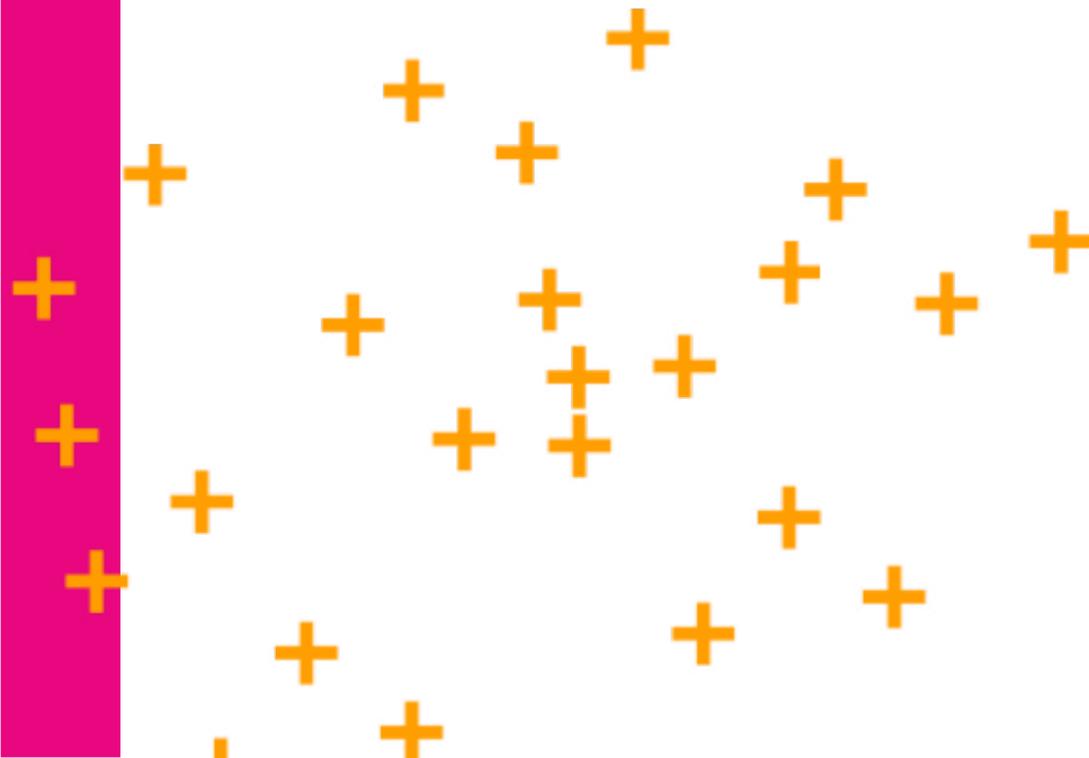
[Learn more](#)

## CHARTWATCH

The CHARTwatch early warning system monitors patients hourly to predict if their condition will get worse, or critical in the subsequent 48 hours. If CHARTwatch detects a high risk patient, it alerts the medical team to intervene. With this early warning system, healthcare providers can ensure timely interventions to help prevent death and prioritize proactive care for patients that can reduce the risk of intensive care unit admission or death for those at high risk.

CHARTwatch was deployed in late 2020 and since its implementation has shown more than 20% reduction in patient mortality rate. It has been fully implemented by the general internal medicine team at Unity Health Toronto's St. Michael's Hospital and expanded to their surgical unit. CHARTwatch will also be deployed at Unity Health's St. Joseph's Hospital site in late 2023.

[Learn more](#)



# CREATING SYNERGY: PARTNERSHIPS EMPOWER AI-FOR-HEALTH

Vector's partnership with the Michener Institute of Education at UHN shows how collaboration can build capacity in Ontario's health sector.



## ACCELERATING THE ADOPTION OF ARTIFICIAL INTELLIGENCE IN HEALTH CARE

The joint Accelerating the Adoption of Artificial Intelligence in Health Care project was aimed at transforming the mindset, skillset, and toolset that the health community brings to AI-enabled practice and care.

With the Michener Institute, Vector co-led:

- The Healthcare AI Innovation Hub, which built an exclusive community for knowledge sharing and networking with individualized support from a national panel of health care AI experts
- The AI-Enabled Mental Healthcare Symposium, which included a panel discussion on how AI is enabling patient-centred care in the mental health space

Through the partnership, two key programs were developed in 2022-23:

- The AI for Clinician Champion Certificate Program, which provided a working knowledge of AI and foundational skills for implementing AI into practice. From 2021 to 2023, +170 clinicians across Canada were trained through the program.
- The AI for Healthcare Leaders Certificate Program, which was designed for senior executives in health and covers the strategic implications of organizational readiness and planning for implementing AI solutions. +50 health leaders were trained through this program.



Vector's new Chief Information Officer, Ben Davies, leads the charge to evolve our technical capabilities and more

While Vector has made strides in improving the accessibility and security of health data for research and application in Canada, our integrated Health and Data teams' objective now is to extend those principles to all forms of data. The integration of AI across various sectors, including health, finance, and government, emphasizes the importance of advancing data governance frameworks, policies, and processes to ensure the responsible and secure utilization of data. Further, as Vector's research community expands, it becomes crucial to enhance technical capabilities and security measures, emphasizing the indispensable synergy between technology and data. That is where Ben Davies, Vector's new CIO, steps in.

**"I am very excited to join the Vector Institute," Ben shares. "Our team will be focused on infrastructure enhancements to support the AI researchers in Vector's community by providing better access to state-of-the-art compute infrastructure and a critical sandbox for Canadian companies looking to compete globally."**

# MIND THE GAP: ENABLING AI DEPLOYMENT IN HEALTH SYMPOSIUM

In November 2022, Vector held the Mind the Gap - Enabling AI Deployment in Health symposium. The event brought together leading experts in AI and health to share insights and lessons learned from real world examples of AI implementation in health settings.

This Symposium was the second iteration of an event that Vector had co-hosted in 2019 in partnership with The Hospital for Sick Children, which showcased early examples of AI solutions moving from the research lab to the clinic. The 2022 iteration of the event welcomed 119 attendees and demonstrated both the results of these early solutions and how world-class machine learning research is actively translating into widespread benefits for patients and the health system.

During the symposium, attendees heard presentations and panel discussions on topics such as:

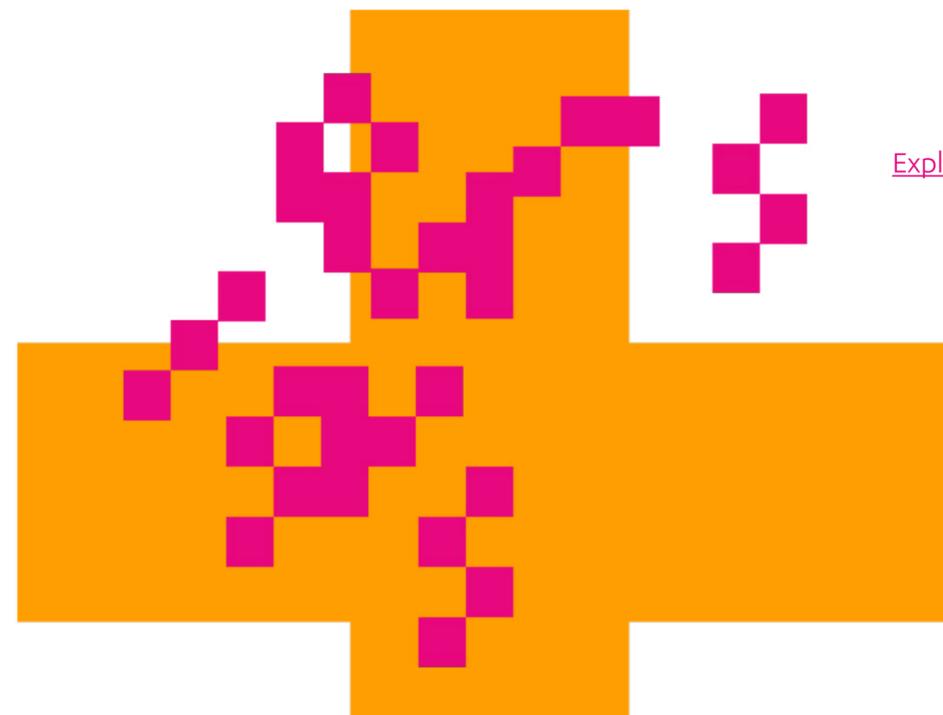
- Challenges of implementing AI in health care
- Designing machine learning for equitable health systems
- Successful AI deployment and adoption in health care
- Future potential of AI in health care

[Learn more](#)

**“ I thought the perspectives were excellent. They were diverse, and they were from true practitioners, which is refreshing. ”**

-Fanny Sie, Head of AI and Emerging Tech Collaborations-Mergers, Acquisitions, Partnering; Roche Global Informatics

[Explore more of the highlights from the 2022 Health AI Deployment Symposium](#)



# AI ENGINEERING

VECTOR IS AT THE FOREFRONT OF AI APPLICATION ACROSS INDUSTRY, HEALTH, AND GOVERNMENTS



**KNOWLEDGE TRANSFER**  
Working directly with AI professionals to build their capacity and expertise



**HANDS-ON GUIDANCE**  
Collaborating on real-world projects to accelerate successful AI deployment



**AMPLIFYING RESEARCH**  
Enabling world-class researchers to unlock and share AI progress to benefit a global community



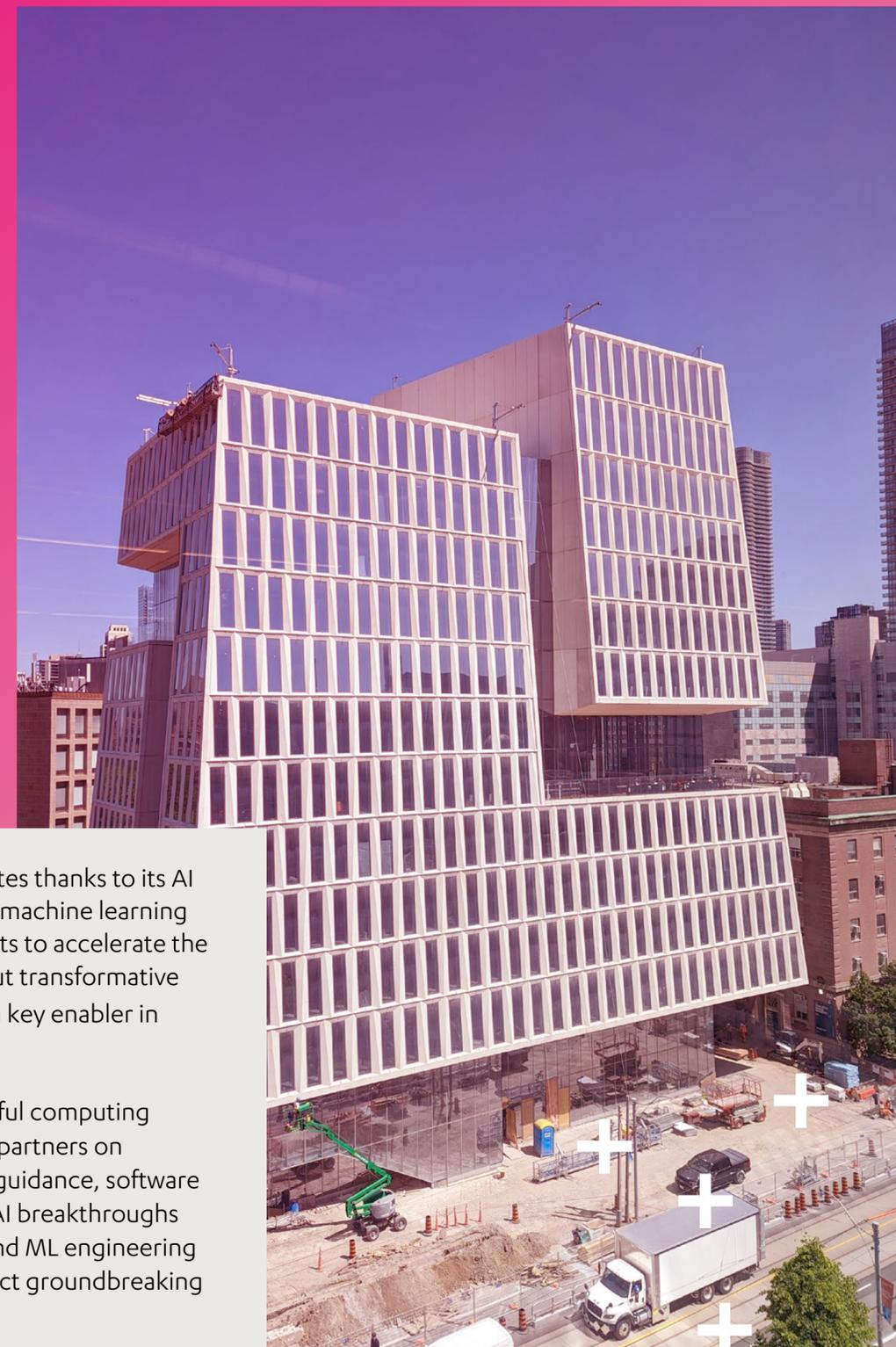
**ENHANCING CANADA'S AI INFRASTRUCTURE**  
Building and maintaining Canada's machine learning computational infrastructure, which is essential to innovation



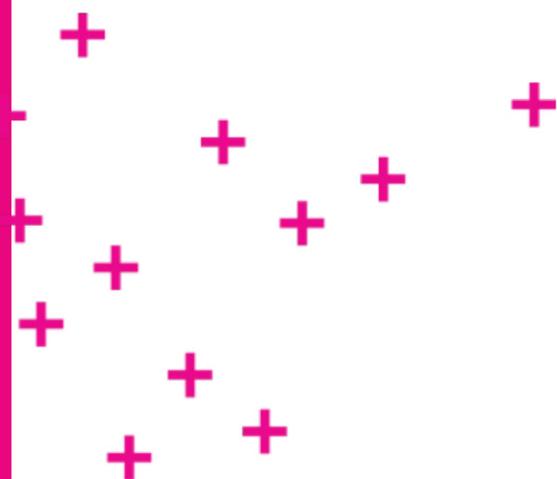
**ENABLING RESPONSIBLE AI**  
Advancing technologies and frameworks that help ensure privacy, fairness, and accountability in AI application

The Vector Institute stands out from other research institutes thanks to its AI Engineering team, a key differentiating factor that enables machine learning engineers and partners in industry, health, and governments to accelerate the responsible deployment of AI solutions that can bring about transformative benefits for all Canadians. The AI Engineering team is also a key enabler in performing and amplifying ambitious AI research.

Through their expertise in applied ML and access to powerful computing resources, Vector's AI Engineering team collaborates with partners on collaborative projects, providing project participants with guidance, software tools, and reference implementations based on the latest AI breakthroughs and guided by real world use cases. The AI infrastructure and ML engineering expertise at Vector, enables affiliated researchers to conduct groundbreaking experiments and push the boundaries of AI innovation.



# DRIVING REAL-WORLD OUTCOMES WITH APPLIED RESEARCH



## 2X

growth in full-time AI Engineering team members dedicated to enabling partners and innovation

## +1,000

GPUs available

## +20

thought leadership successes (papers, knowledge contribution, etc.)

Vector's AI Engineering team is programmatically focusing on the following areas to help make the connection between ground-breaking research through to impactful projects and real-world applications:

### INDUSTRY ADOPTION

Vector's AI Engineering team plays a pivotal role in bringing AI solutions to life for practical business applications. For instance, in 2022-23, the team collaborated with sponsors from the finance sector, enabling them to leverage their data for tasks like automated forecasting for ATM machines and enhanced fraud detection capabilities.

### HEALTH DEPLOYMENT

With a focus on improving patient outcomes, Vector's AI Engineering team is dedicated to safely advancing AI research for practical application in health care. As an example, Vector collaborated with the University of Toronto and GEMINI, housed in Unity Health St. Michael's Hospital, to create an AI tool aimed at identifying hospital delirium rates. Delirium, a condition that increases the risk of death twofold during hospitalization, could be prevented in 20-40 per cent of cases with timely intervention. Leveraging electronic health record data, the AI tool could be used to predict the occurrence of delirium, prompting health care providers to use preventive measures when required.

### FOUNDATION MODELS

Foundation models represent a new paradigm in the field of AI, revolutionizing the way we approach and develop AI systems. Their ability to learn from vast amounts of unlabeled data allows them to acquire a broad understanding of various domains and tasks. This general knowledge serves as a foundation upon which specific applications can be built and fine-tuned. The AI Engineering team has built tools, frameworks, and services to effectively leverage these large language models (LLMs) by enabling inference, inspection, and customization for specific domains and tasks. AI Engineering is also actively working on ensuring the power of foundation models can be applied to various domains like climate change and health. The Kaleidoscope tool, developed by AI Engineering, optimized model deployment and offers capabilities to investigate the inner workings of these LLMs. This is a key enabler for doing research as well as accelerating adoption.

[Learn more about Kaleidoscope](#)

### RESPONSIBLE AND TRUSTWORTHY AI

The responsible and trustworthy AI initiative aims to ensure ethical practices and accountability are built into Vector's AI Engineering team. By prioritizing responsible development, transparency, and user-centric design, the AI Engineering team strives to build AI systems that foster trust and mitigate potential risks. Through ongoing education, rigorous evaluation, and continuous improvement, the team is committed to creating AI solutions that benefit society while upholding ethical standards

While every initiative is evaluated with the lenses of responsible AI, some initiatives contribute directly to advancing certain aspects. One example is the evaluation framework, which is at the core of CycLOps, a product that is focused on rigorous domain specific evaluation of the model through its lifecycle

### AI FOR SCIENCE

Looking ahead, the AI Engineering team aspires to empower researchers, industry, and health partners with cutting-edge machine learning tools and techniques to accelerate scientific discoveries and gain insights from complex data.

As an example, Vector's AI Engineering team partnered with U of T's Acceleration Consortium and released Gryffin, a tool for designing functional molecules and advanced materials, amplifying cutting edge research in AI for materials discovery.

[Learn more](#)

# KALEIDOSCOPE

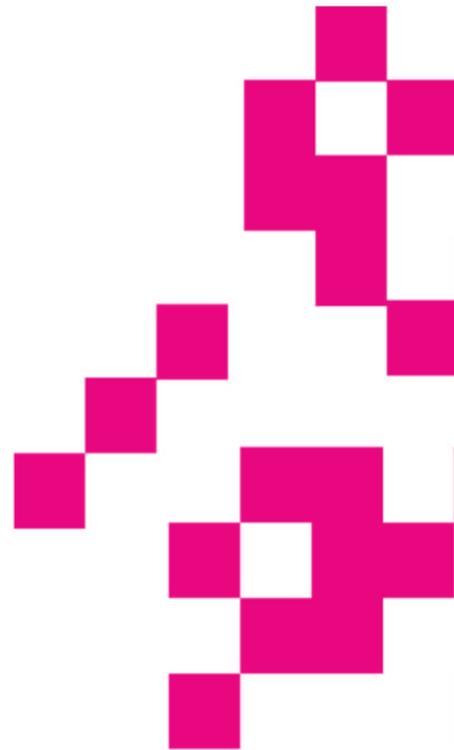
EMPOWERING RESEARCHERS AND INDUSTRY SPONSORS WITH  
ADVANCED MODEL SERVING AND INTROSPECTION CAPABILITIES  
FOR LARGE LANGUAGE MODELS

The Kaleidoscope - FM Model Serving Framework and SDK is a tool developed to deploy foundational models on-demand. As an open source model, Kaleidoscope empowers researchers and industry partners who may not have technical knowledge. Instead of worrying about how to get started, users can simply use Kaleidoscope to dive right in and experiment with foundation models.

The engagement with Kaleidoscope has been substantial, with almost 100 users from both Vector and industry sponsors using it over 700,000 times in 2022-23. Additionally, Kaleidoscope has supported two cohorts of Prompt Engineering bootcamps.

For the bootcamps, Kaleidoscope was set up ahead of time so industry sponsors could come in and test foundation models out, giving non-technical users a chance to get started.

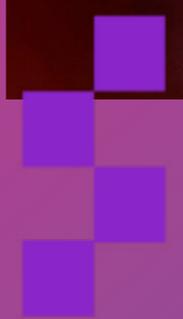
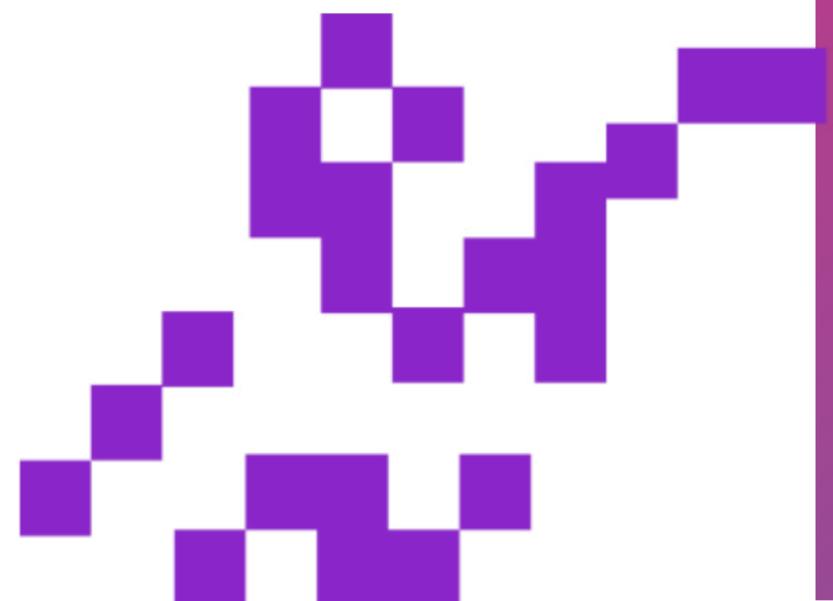
For researchers, Kaleidoscope has played a vital role in enabling the scaling of foundational model workloads on the Vector Cluster. This support has resulted in the creation of two derived publications and over 50 citations, showcasing the framework's impact on research outcomes.



# THOUGHT LEADERSHIP

## VECTOR IS LEADING DISCUSSIONS ABOUT THE SOCIETAL AND ECONOMIC BENEFITS OF AI

Actively engaging in discussions at the local, national, and global levels, Vector is building an influential voice on AI's societal and economic impacts by contributing to key topics, including research, responsible AI, workforce development, and economic competitiveness. Additionally, Vector experts often share insights on policy issues related to AI adoption to promote the best interests of Ontarians and Canadians and to amplify Canada's voice in the global AI space.



# 2022-2023 HIGHLIGHTS

## AMPLIFYING IDEAS

- Vector's senior leadership and research community regularly lends its AI expertise to national and international media in areas including health, scientific computing infrastructure, safe AI, and AI-related policy
- Vector and its affiliated Canada CIFAR AI Chairs were mentioned more than 9,424 times in media articles in 2022–23 - three times the number of mentions in 2021-22
- Vector's senior executives and faculty were interviewed by dozens of media outlets in 2022-23 including *The Globe and Mail*, *The Toronto Star*, *The National Post*, *The Financial Post*, *The Logic*, *BetaKit*, and many more
- Roxana Sultan, Chief Data Officer and VP, Health contributed an op-ed to *The Toronto Star* about the possibilities of AI to alleviate health system pressures, furthering conversation about the positive impact of AI for patients

## ELEVATING DIALOGUE

Throughout the past year, Vector continued to foster dialogue and discussion of AI and its potential for societal and economic impact.

Topics for discussion during 2022–23 included:

- The risks and immense potential of generative AI
- The unique intricacies of protecting AI innovation through intellectual property law
- The leading role Canada can play in AI for Science

## CONTRIBUTING EXPERTISE

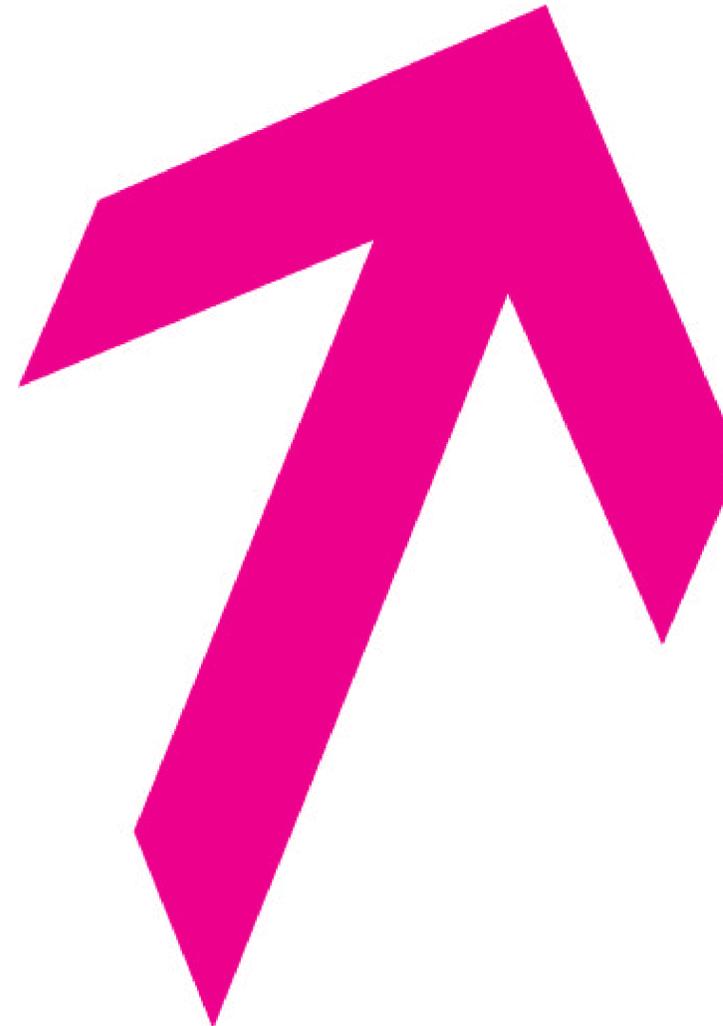
Many members of Vector's community participated in discussions related to AI and its role in economic development and health policy, and responsible AI data governance, providing both advice and recommendations to governments and industry leaders.

Highlights from 2022–23 include:

- Consultations with the Government of Canada on Bill C-27
- Ongoing participation in Canada's Advisory Council on Artificial Intelligence, including topics such as commercialization and public awareness and, more recently, generative AI

Vector representatives also participated in nearly 50 external conferences, panels, and events in 2022–23, including these highlights:

- AAI Conference 2023
- NeurIPS 2022
- RLDM 2022
- ACL 2022
- ICLR 2022
- Neural Scaling Laws Workshop



# TEAM AND LEADERSHIP

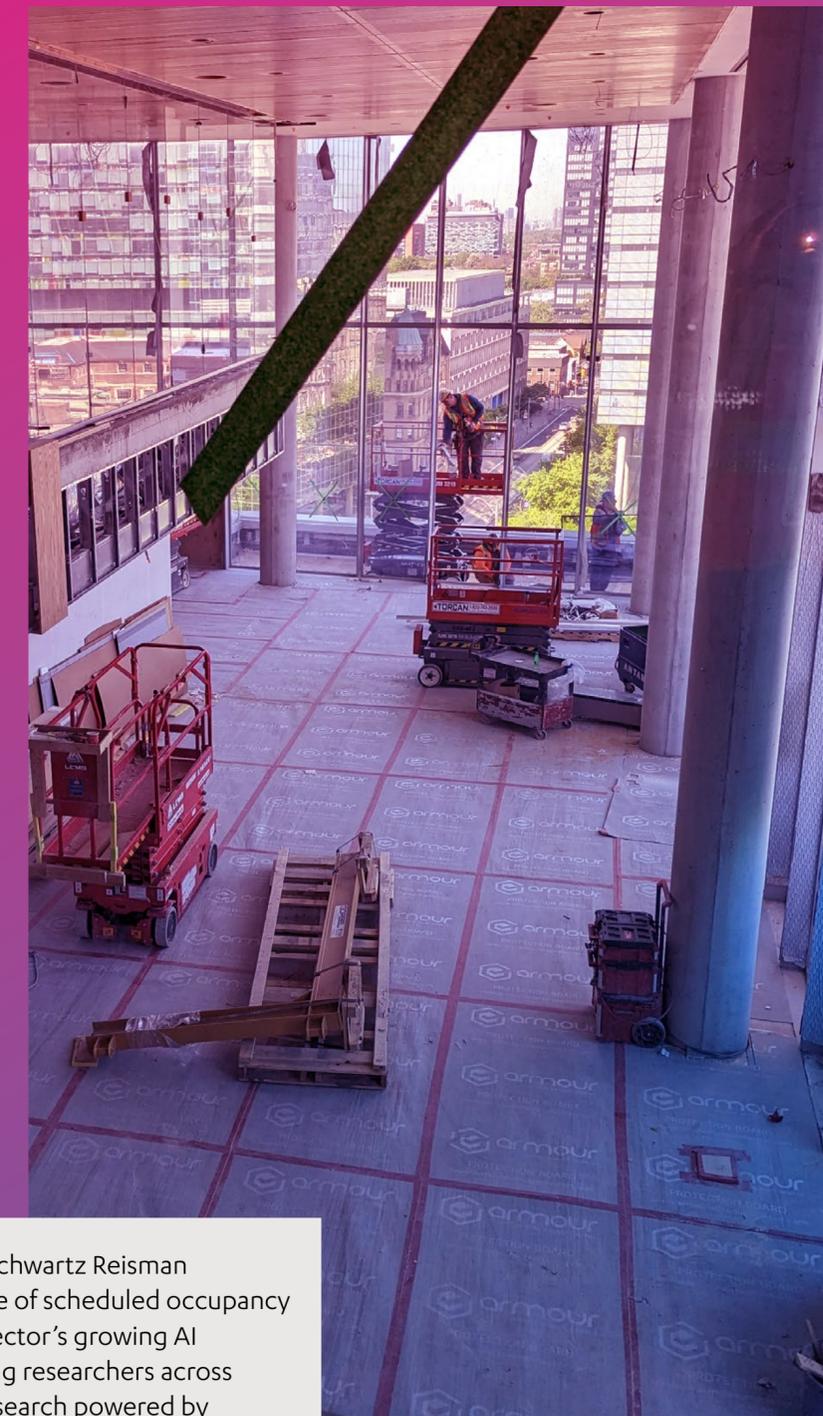
The Vector Institute is governed by a distinguished Board of Directors, comprising accomplished professionals from various sectors, including academia, research, public sector, and private industry.

## VECTOR'S MEMBERS OF THE CORPORATION AND BOARD OF DIRECTORS AS OF MARCH 31, 2023 ARE:

- Ed Clark, Chair**
- Janet Bannister**
- Charmaine Dean**
- Janet L. Ecker**
- Chaviva Hosek**
- Nadir Mohamed**
- Michael Serbinis**
- Terrence Sullivan**
- Melanie Woodin**

## LEADERSHIP AS OF MARCH 31, 2023

- Tony Gaffney, President and CEO**
- Gary Burlakoff, Director, Finance**
- Ben Davies, Chief Information Officer**
- Melissa Judd, Vice President, Research Operations and Academic Partnerships**
- Deval Pandya, Vice President, AI Engineering**
- Cameron Schuler, Chief Commercialization Officer and Vice President, Industry Innovation**
- Roxana Sultan, Chief Data Officer and Vice President, Health**
- Graham Taylor, Research Director**
- Alan Veerman, Chief Operations and Financial Officer**



Construction of Vector's future home at the Schwartz Reisman Innovation Centre (SRIC) continues in advance of scheduled occupancy in 2023-24. The new facility aims to support Vector's growing AI community by promoting collaboration among researchers across institutions and enabling machine learning research powered by high-performance computing equipment.



# FINANCIALS

Vector is funded through multi-year commitments from different funding sources, including:

- Funding through the Government of Ontario's Ministry of Economic Development, Job Creation and Trade (MEDJCT) to establish the institute, deliver core programming, and support the development of the AI ecosystem, including workforce development, scholarships, and support to develop AI master's programs.
- Funding from the Government of Ontario's Ministry of Colleges and Universities for Vector's Smart Health initiative.
- Federal funding from the Government of Canada through the Pan-Canadian AI Strategy (PCAIS) – Talent and Research, administered by CIFAR, to support research and education, including the Canada CIFAR AI Chairs Program.
- Funding from the Government of Canada through the PCAIS – Commercialization, administered by Innovation, Science and Economic Development Canada (ISED), to support Vector's AI commercialization programming and activities, including the FastLane program.
- Industry sponsorships at various levels and commitments that support Industry Innovation programs and related initiatives.

The Vector Institute's audited financial statements for the 2022-23 fiscal year are available on the [Vector Institute website](#).

## STATEMENT OF FINANCIAL POSITION

March 31	2023	2022
<b>Assets</b>		
<b>Current</b>		
Cash	\$ 7,508,656	\$ 50,635,501
Short-term investments	40,756,296	-
Accounts receivable	4,553,106	5,458,619
Current portion of employee loans	275,778	289,375
HST receivable	64,244	109,394
Prepaid expenses	2,552,640	2,897,941
	<b>55,710,720</b>	59,390,830
Employee loans	834,217	970,975
Capital assets	3,502,395	2,863,902
	<b>\$ 60,047,332</b>	\$ 63,225,707
<b>Liabilities and Net Assets</b>		
<b>Current</b>		
Accounts payable and accrued liabilities	\$ 4,504,122	\$ 3,623,949
Deferred rent	-	209,429
Deferred contributions	1,365,811	5,069,837
Deferred capital contributions	1,239,416	2,692,021
	<b>7,109,349</b>	11,595,236
<b>Net Assets</b>		
Unrestricted net assets	52,937,983	51,630,471
	<b>\$ 60,047,332</b>	\$ 63,225,707

# FINANCIALS

## STATEMENT OF CHANGES IN NET ASSETS

For the year ended March 31	2023	2022
Net assets, beginning of year	\$ 51,630,471	\$ 42,043,897
Excess of revenue over expenses for the year	<b>1,307,512</b>	9,586,574
Net assets, end of year	<b>\$ 52,937,983</b>	\$ 51,630,471

## STATEMENT OF OPERATIONS

For the year ended March 31	2023	2022
Revenue		
Government grants		
Province of Ontario	\$ 4,624,256	\$ 11,289,494
Government of Canada		
PCAIS - Talent and Research	8,393,843	7,189,694
PCAIS - Commercialization	3,829,412	2,170,588
Industry partners	9,533,333	9,650,000
Amortization of deferred capital contributions	1,452,605	2,517,839
Investment income	1,735,750	384,156
Fees for service	286,572	400,577
	<b>29,855,771</b>	33,602,348
Expenses		
Research and education	9,287,515	8,442,600
Industry skills training	183,758	61,735
Technology adoption	6,136,011	4,746,437
Business acceleration	3,468,126	2,357,297
General and administration	4,886,527	3,463,680
RAISE AI	2,493,273	2,096,966
Employee loans accretion expense (recovery)	130,355	(14,543)
Amortization	1,962,694	2,861,602
	<b>28,548,259</b>	24,015,774
Excess of revenue over expenses for the year	<b>\$ 1,307,512</b>	\$ 9,586,574