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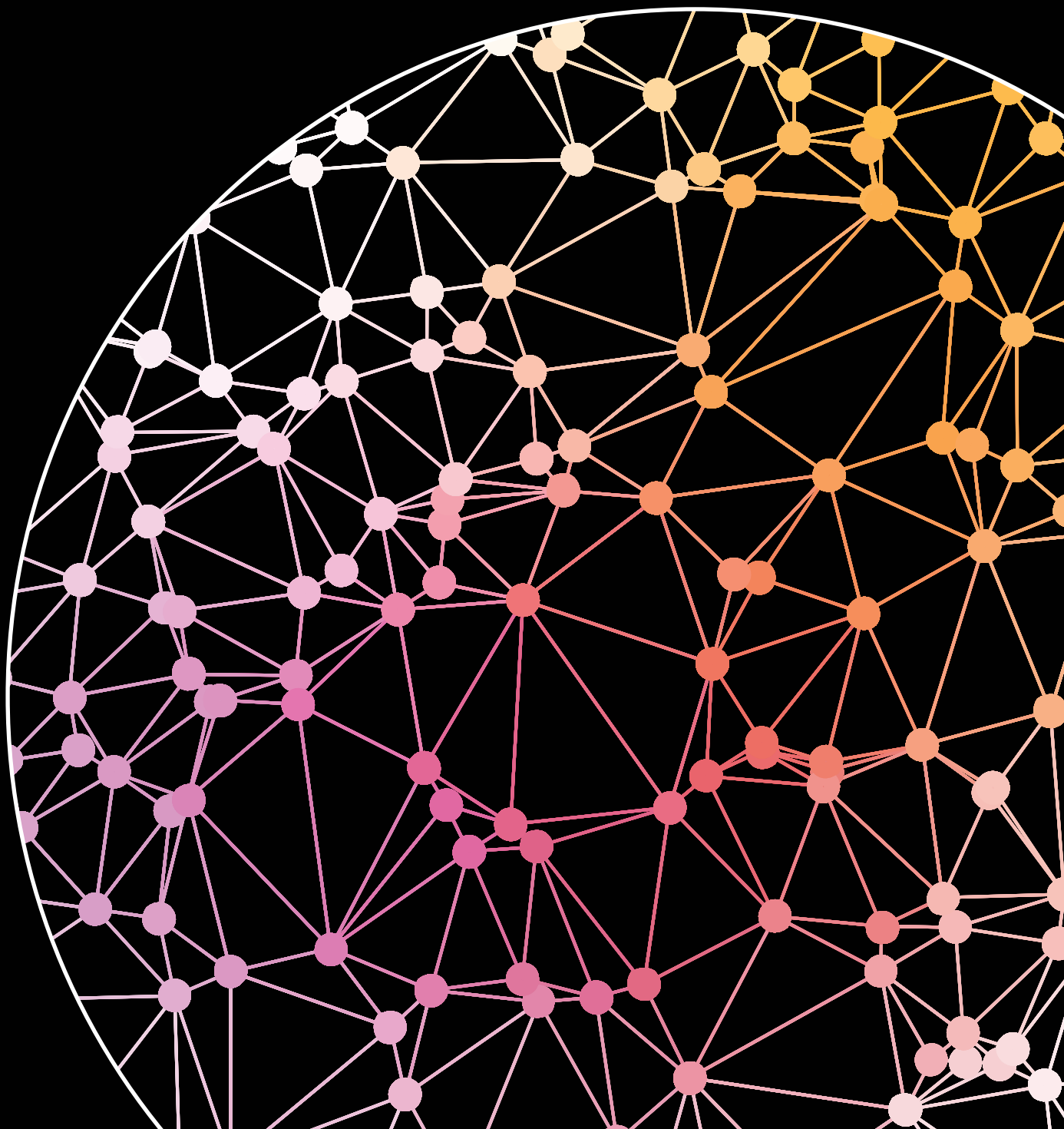
Ontario AI snapshot

The state of the province's AI ecosystem in 2019/20

Produced by Deloitte on behalf of the Vector Institute



About the Vector Institute

The Vector Institute is an independent, not-for-profit corporation dedicated to advancing the field of AI through world-class research and applications, specializing in the areas of deep learning and machine learning. The Vector Institute launched in 2017 through the foresight, collaboration, and generous support of the Government of Canada, the Province of Ontario, industry leaders from across the country, and AI trailblazers at the University of Toronto.

Its founders established the Vector Institute to help drive excellence and leadership in Canada's knowledge, creation, and use of AI to foster economic growth, and improve the lives of all Canadians. And they believed that the Vector Institute would play a pivotal role in building a critical mass of AI talent.

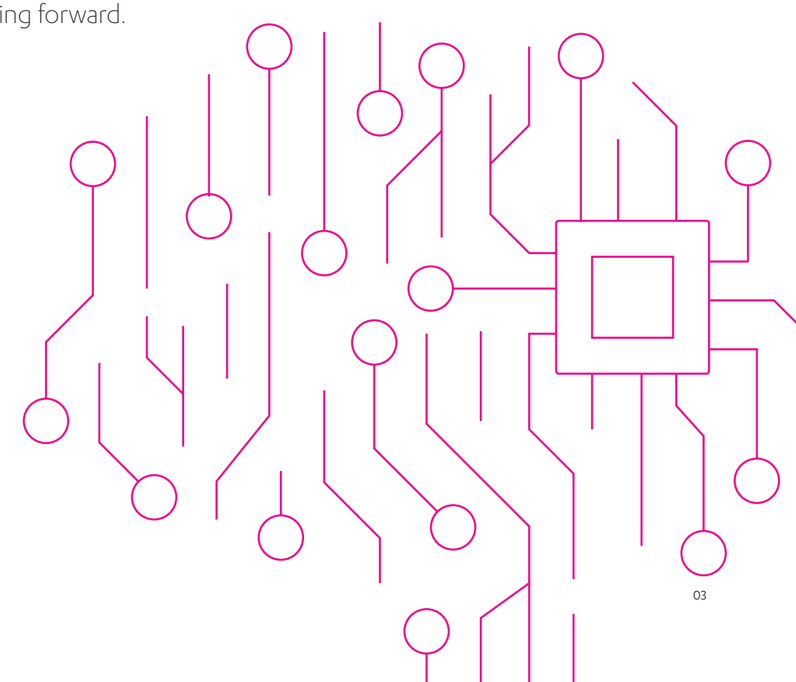
Today, the Vector Institute is a pillar of Ontario's AI ecosystem, sitting at the very heart of the Toronto-Waterloo innovation corridor and more than 200,000 technology workers—North America's largest tech cluster outside of Silicon Valley.[1]

In 2020, the Vector Institute unveiled a new three-year strategy[2] to build on its achievements to date. This strategy expands successful research programs, introduces new initiatives related to AI talent, commercialization, and application, and leads Canada towards the responsible and effective use of AI.

Introduction

As an organization that has received funding support from the Government of Canada, the Province of Ontario, and a broad cross-section of companies to further Ontario's AI ambitions, the Vector Institute has a responsibility to report on key indicators for the health of the province's AI ecosystem.

This report, developed and published by Deloitte in partnership with the Vector Institute for the first time, is designed to provide a snapshot of the state of Ontario's vibrant AI ecosystem in 2019/20 (April 1, 2019 to March 31, 2020) and serve as a benchmark going forward.



With Vector's assistance, we have developed a methodology to assess the state of Ontario's AI ecosystem, focusing on 10 key metrics:

Talent and job market

1. Highly qualified AI professionals (HQPs)[1] attracted and trained
2. AI-related jobs created and retained
3. The number of well-paying AI jobs for HQPs who have graduated from AI-related programs

Investment and adoption activity

4. AI-related patents filed
5. AI research and development expenditure and research funding
6. AI companies investing in, or relocating to, Ontario
7. Venture capital investments in AI in Ontario
8. New AI companies established
9. Firms adopting AI solutions
10. AI product/service commercialization

We believe these 10 metrics serve as effective indicators of the overall health of those aspects of Ontario's AI ecosystem of particular interest to governments and the business community: jobs, investment, application, and commercialization. These metrics offer insights into the pace of AI job creation and the depth of Ontario's AI talent pool. They capture the investments being made to develop AI businesses and solutions and advance AI research. They also provide a window into the potential growth of Ontario's AI market as companies develop, commercialize, or embrace AI solutions for their businesses. Furthermore, these metrics can be measured using readily available data.

The 10 metrics we have selected for this report should not be seen as providing a fully comprehensive view of Ontario's AI ecosystem, but rather as indicators of the ecosystem's health and overall direction. This report is also intended to be the benchmark for future assessments of the ecosystem's progress year over year, an ongoing initiative to ensure Vector's partners are kept updated on how Ontario's dynamic community of AI innovators, entrepreneurs, and risk-takers are keeping Ontario and Canada at the forefront of AI development globally.

[1] This report uses the term "highly qualified professionals" (HQP) to denote individuals with university degrees at the bachelors' level or above.

Our methodology

The Vector Institute, together with Deloitte, employed a combination of research and external databases to obtain the information used for this report.

Modus Research was engaged to conduct a survey of 151 business executives and senior managers in enterprises and universities operating in Ontario. The survey was carried out from June 16 to July 10, 2020. Participants were screened from an established executive business panel developed by Modus Research in partnership with Deloitte. The Modus Business Panel is Canada's gold standard for B2B research and has broad Canadian business coverage across all sectors and industries.

All 151 survey participants came from organizations that were either AI developers, offered AI services, used AI to drive their services, or had immediate plans to use AI to improve their services in the next year. Eighty-two percent of survey participants stated that at least one-quarter of their organization's revenue came from Ontario.

In addition, market research was conducted using government patents databases and QUID, a company/industry research portal. Finally, some results were interpolated using a combination of university outreach and data from the Vector Institute.

2019/20 snapshot: Key insights

Key insights in this first snapshot comprise a baseline, against which future progress can be measured.

As of 2019/20, over 1,000 master's students had enrolled in AI programs across the province and an estimated 3,683 AI jobs were created in Ontario. Millions of dollars were invested in Ontario AI research and development. More than 160 companies invested in or even relocated to the province in order to capitalize on the critical mass of AI talent found here, and Ontario's AI ecosystem attracted $1.9 billion in venture capital. An estimated 32 new AI companies were founded. And approximately half of the firms we surveyed said AI was strategically important and being commercialized in their business in some way.

These programs are contributing to an increase in AI candidates ready to enter the Ontario economy. As of March 31, 2020, there were over 1,000 AI master's students enrolled in a combination of Vector-recognized programs and individual AI study paths (i.e., 815 master's students enrolled in Vector-recognized programs and a further 315 students in individual AI-related study paths) at universities across Ontario (see next page).

Students and graduate researchers at Vector

The Vector Institute has created a community of premier AI talent by attracting and retaining top machine learning and deep learning researchers. We have grown our research community from eight founding Faculty Members in 2017 to a diverse group of over 500 researchers representing 15 universities across Canada, including 120 faculty, 60 undergraduate students, 91 master's students, 195 PhDs and 35 post-doctoral fellows.

Talent and job market

1 As of March 31, 2020, in Ontario there were over 1,000 students enrolled in AI-related master's programs and at least 302 AI master's graduates.

In 2019/20, demand for AI talent was strong across Canada, with 45–53 percent of Canadian businesses planning to hire externally for these roles[3]. Ontario is training the highly qualified AI talent Canada wants.

AI master's talent

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

Ontario universities have responded quickly to employers' increased demands for AI talent. As of March 31, 2020, Vector's committee of industry representatives and faculty had recognized 22 AI-master's programs across Ontario for training graduates with the skills and competencies sought by industry. Of these 22 programs, four are brand-new degree programs and 12 are programs whose curricula have been updated to offer AI-specific minors, concentrations, and courses.

2 An estimated 3,683 AI jobs were created and 16,205 AI jobs were retained in Ontario in 2019/20.

Ninety-seven percent of the business executives surveyed for this report said their organizations created AI jobs in Ontario in 2019. The vast majority (91 percent) said that their organizations created between 1 and 10 AI roles; 5 percent of respondents reported creating between 11 and 60 AI jobs, and 1 percent said their organization created between 200 and 400 AI jobs.

This translates into an estimated 3,683 new AI jobs created in Ontario during the 2019/20 period covered by this report. To calculate this figure, we made an assumption that survey respondents' organizations created 5, 30, or 300 new AI jobs (i.e., the midpoint of the range for their response) and multiplied that against the estimated number of AI companies in Ontario (407, according to our research).

We also applied a job retention multiplier (4.4 jobs retained for each job created[4]) to the figure of 3,683 new AI jobs to determine that Ontario also retained 16,205 AI jobs in 2019/20.

AI master's programs and related study paths at Ontario universities

Carleton University
MASc in Biomedical Engineering
MSc in Computer Science
MA in Economics
Master of Cognitive Science
Master of Information Technology, Digital Media (Data Science)

Lakehead University
MSc in Computer Science (AI) *
MSc in Electrical & Computer Engineering

McMaster University
MSc in Computational Science and Engineering
MASc in Electrical and Computer Engineering
MSc in Computer Science

University of Guelph
Collaborative Specialization in Artificial Intelligence*

Ontario Tech University
Master of IT Security (AI)*
MSc in Computer Science

Queen's University
MSc in Computer Science (AI) *
MASc in Electrical and Computer Engineering (AI)*
Master of Management in Artificial Intelligence*
Master of Management Analytics*
MASc in Mining Engineering

Ryerson University
M.Eng in Electrical, Computer and Biomedical Engineering (AI)*
MSc in Data Science and Analytics*

University of Windsor
MSc in Computer Science (AI) *

University of Ottawa
MSc in Computer Science (Applied AI) *
M.Eng & MASc in Electrical & Computer Engineering (Applied AI)*
MSc in Epidemiology

University of Toronto
MASc in Aerospace Studies
MSc in Applied Computing
MSc in Computer Science
MASc in Biomedical Engineering
MASc in Electrical and Computer Engineering
MASc in Mechanical and Industrial Engineering
Master of Health Informatics*
MSc in Statistics
Master of Management Analytics*
MSc in Health Policy, Management and Evaluation (AI)*
MASc in Chemical Engineering

University of Waterloo
M.Math in Computer Science
M.Math in Statistics (Data Science Specialization)**
MASc in Systems Design Engineering
M.Math in Data Science*
Master of Data Science and Artificial Intelligence*
MASc in Civil and Environmental Engineering
MASc in Electrical & Computer Engineering

Western University
MSc in Computer Science; MEng & MSc in Electrical and Computer Engineering (Collaborative Specialization in AI)*
Master of Data Analytics (AI)*

York University
Master of Business Analytics*
MSc in Computer Science (AI) *
Master of Management in Artificial Intelligence*

* Vector-recognized program
**Program no longer accepting students. Curriculum evolved and is now offered through the University of Waterloo's M.Math in Data Science and Master of Data Science and Artificial Intelligence.

3 Ontario created an estimated 1,602 well-paying jobs held by HQPs graduated from AI-related programs.

According to our survey of business executives, 1,602 of the 3,683 AI jobs created in 2019/20—and held by HQP graduates from an AI-related program—could be considered well-paying positions with salaries greater than $70,000 per year.

Investment and adoption activity

4 55 new AI-related patents were filed in Ontario in 2019/20.

Patent filings, along with venture capital investments, integration of AI research into products and processes, and other factors, are indicators of commercialization activity.

Our search of the Canadian Intellectual Property Office's patents database for a wide range of AI-related terms—such as "artificial intelligence," "machine learning," "data science," "artificial neural networks," "predictive analytics," "deep learning," "computer vision" and more—found that 55 related patents were filed between April 1, 2019 and March 31, 2020.[5] To arrive at this final number, search results were scored and manually reviewed for AI-relevance. Results were also filtered to include only inventors based in Canada.

5 Between $97 million and $824 million was spent on AI research and development in Ontario in 2019/20 (i.e., budgeted R&D expenditures and allocation of external funding).

Ontario's businesses are investing in AI-related R&D activity, whether through budget allocations or external funding.

Forty percent of the business leaders surveyed for this report said they allocated up to $25,000 of their organization's 2019 budget to AI-related research; 23 percent devoted $25,000 to $100,000; 10 percent said their organizations spent between $100,000 and $1 million; another 10 percent invested from $1 million to $10 million; and 1 percent said they budgeted $100 million or more.

External funding is also being used to support AI research. Twenty-six percent of survey respondents said they invested up to $25,000 of external funding into AI-related R&D in 2019; a further 6 percent invested between $25,000 and $100,000; 12 percent invested between $100,000 and $1 million of external funding into AI; and 2 percent invested from $1 million to $50 million.

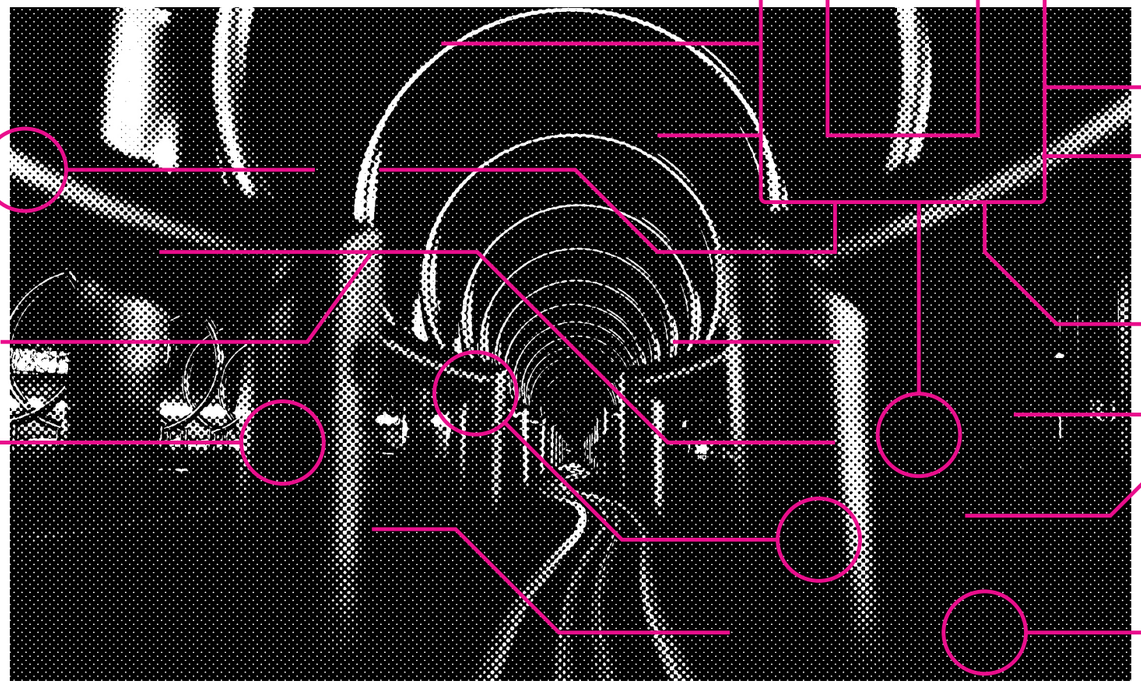
As our survey data returned rather sparse results in terms of expenditures towards the higher end of the ranges discussed, we elected to supply three estimates as to the likely level of AI R&D investment across Ontario's AI ecosystem during the 2019/20 period covered by this report. At the most conservative end of the spectrum, AI R&D investment could come in around $97 million; at the opposite end, the estimated level of investment could be as high as $824 million. Between these two extremes, we concluded that a mid-range estimate of Ontario's AI R&D spending would be approximately $327 million.

6 In 2019/20, there were an estimated 12 companies moving to the Ontario AI ecosystem and 166 companies investing in it.

Ontario is home to hundreds of AI-enabled companies at various stages of development, from fledgling startups to fast-growing entrepreneurial ventures to larger, more established players. For companies eager to invest in and reap the potential business and financial rewards of AI, Ontario is a highly attractive destination for those investments. For other companies, Ontario's AI ecosystem offers advantages and opportunities powerful enough to relocate operations here.

We used the QUID market research application to estimate the number of unique investors that made direct investments—either private investments or minority stakes—into Ontario-based AI companies between April 1, 2019 and March 31, 2020.[6] We found that between the dates noted above, 166 unique investors made direct investments into Ontario AI companies.

In addition, 3 percent of the business executives surveyed for this report indicated that their organization had relocated offices or operations to Ontario from other jurisdictions. To determine the number of companies this figure represented, we multiplied the estimated number of AI companies from our prior research (407) by 3 percent—concluding that an estimated 12 companies found Ontario's AI ecosystem to be worth moving into.



7 $1.9 billion in venture capital investments flowed into Ontario's AI ecosystem in 2019/20.

Companies aren't the only ones investing in Ontario's promising AI companies: Venture capital investors poured significant funding into our AI ecosystem to support the continued growth and development of the sector.

Using the QUID market research application,[7] we were able to identify venture capital investments in Ontario-based AI companies between April 1, 2019 and March 31, 2020. These search results were further refined using a manual process to focus on completed venture capital investments in order to arrive at a figure closer to the true value of venture capital investment during this period.

In total, we identified USD$1.435 billion ($1.904 billion)[8] in venture capital investments in Ontario's AI companies in the period covered by our research. In comparison, Deloitte research found that in 2018, Ontario firms received $1.551 billion in venture capital funding—almost half (47 percent) of the $3.3 billion in VC funding that flowed into Canadian AI firms that year.[9]

These figures indicate that venture capital investors see Ontario's AI ecosystem as an important play for the long term. This level of funding is both a statement of intent—and a recognition of the tremendous potential inherent to the sector.

Ontario AI snapshot: The state of the province's AI ecosystem in 2019/20 | Investment and adoption activity

8 An estimated 32 new AI companies were established in Ontario in 2019/20.

In Ontario's AI ecosystem, forward-thinkers and risk-takers launched new companies to capitalize on the province's fertile environment for AI research and application.

We estimate that 32 new AI companies were founded in Ontario between April 1, 2019 and March 31, 2020. To determine this figure, we used the QUID market research application to first identify how many companies operating in AI-related fields were founded in Canada between January 1, 2019 and May 30, 2020.[10]

We then reviewed the result of this analysis manually to zero in on those companies with a presence in Ontario. To finalize our estimate, we weighted the results of our research based on the number of overlapping months between our QUID research period (January 1, 2019 to May 30, 2020) and the period covered by our report (April 1, 2019 to March 31, 2020).

These new additions to Ontario's AI ecosystem add to the critical mass already building here. Deloitte research found that in 2018, Ontario was home to approximately half (54 percent) of Canada's AI companies—and three out of four Ontario AI firms called the Toronto-Waterloo corridor home.[11] No other AI ecosystem in Canada can match the sheer density of AI firms found in Ontario. We are building something truly special in the province.

9 Nearly half (44 percent) of business executives consider AI to play a strategically important role in achieving their company's business objectives.

Ontario companies are realizing the potential for AI to transform how they do business and to open up new opportunities. Nearly half (44 percent) of the business executives we surveyed for this report said that their organization considers AI to have a strategically important role to play in achieving its business objectives.

10 More than half (53 percent) of Ontario companies have commercialized AI products or services or use AI to sell their core products or services.

More than half (53 percent) of the business executives surveyed for this report indicated that their organization has commercialized AI in some fashion. Nine percent of survey respondents said their organization was an AI developer or pursued a core business of delivering AI-related products or services to clients. Another 44 percent of respondents said that their organization uses AI in order to deliver its products or services.

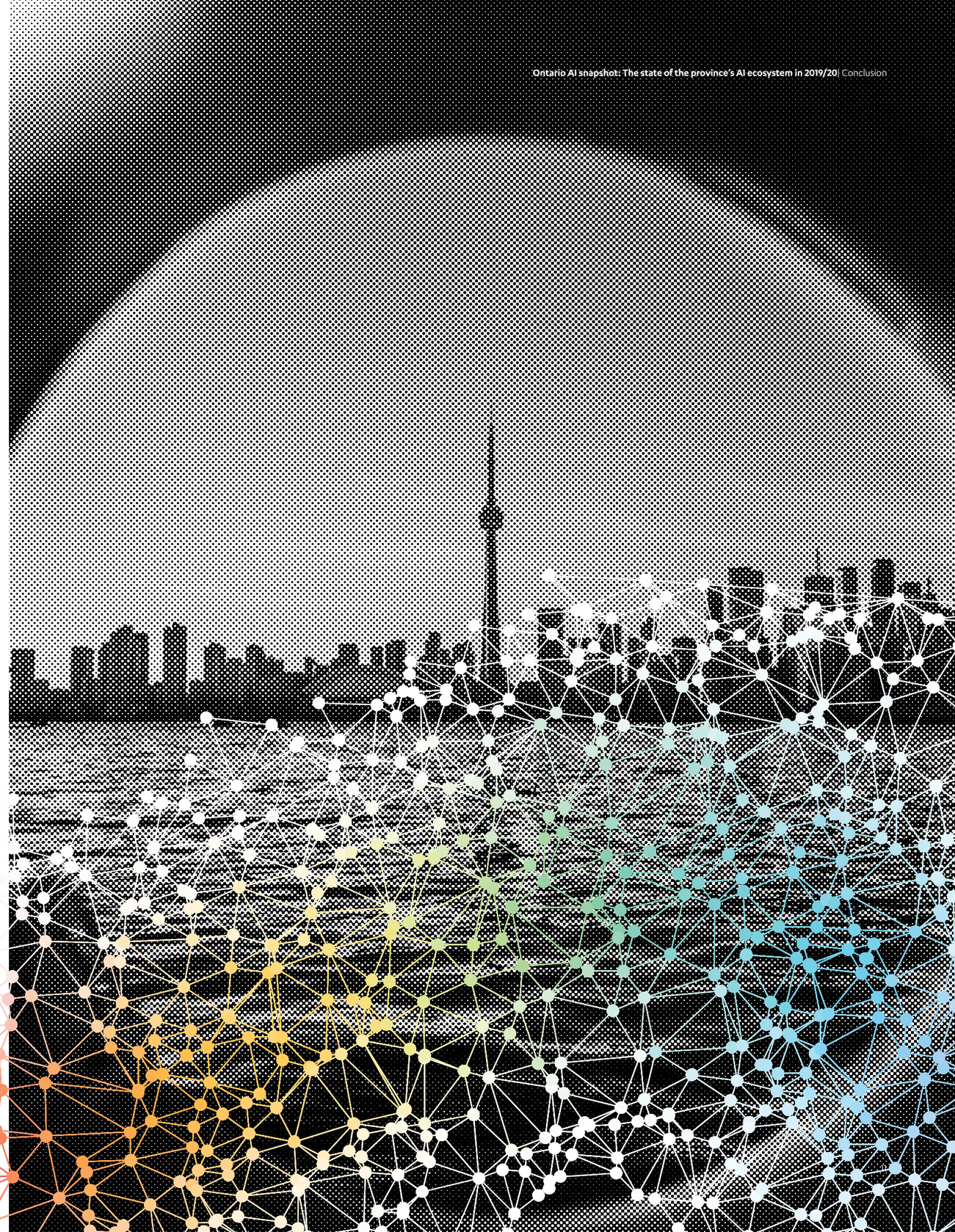
Ontario's AI journey has only just begun

This report is a snapshot of the state of Ontario's AI ecosystem between April 1, 2019 and March 31, 2020. The Vector Institute intends to use this report as the baseline for ongoing, regular assessments of the year-over-year progress and success of Ontario's AI ecosystem.

In 2017, Vector's founders hypothesized that a critical mass of AI talent would enable significant investment, job creation, and commercialization. We are confident that ongoing collaboration and investment among businesses, academia, and public institutions will continue to deliver important benefits and position the ecosystem for growth and resilience.

As well, we are confident that as the world continues to grapple with the health, economic, and social challenges and impacts of the COVID-19 pandemic, Ontario's AI ecosystem will play an integral role in our province's recovery. AI will facilitate the transformation of how we live and work. It will spur innovations that enable Ontario companies to compete and win on the global stage. And it will spark advances in healthcare that will benefit all Ontarians, from better treatments to better services overall. Ontario's AI ecosystem will, in short, help create a better Ontario.

Ontario AI snapshot: The state of the province's AI ecosystem in 2019/20 | Conclusion



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Endnotes

1 Waterloo EDC, https://blog.waterlooedc.ca/what-is-toronto-waterloo-corridor. Retrieved Nov 2, 2020.

2 Vector Institute, https://vectorinstitute.ai/2020/06/18/unveiling-the-vector-institutes-new-three-year-strategy/. Retrieved Dec 14, 2020.

3 Source: Deloitte State of Cognitive 2020 Survey.

4 Source: Deloitte research.

5 The full list of search terms used in the patent research for this report: "Artificial Intelligence" OR "k-nearest neighbor classifiers" OR "support vector machines" OR "classification trees" "back propagation" OR "data science" OR "image recognition" OR "health informatics" OR "big data" OR "quantitative analytics" OR "artificial neural networks" OR "Auto Encoders" OR "Naive Bayes" OR "Random Forest" OR "Generative Adversarial Network" OR "reinforcement learning" OR "Natural Language processing" OR "predictive analytics" OR "pattern identification" OR "pattern recognition" OR "natural language processing" OR "optical character recognition" OR "computer vision" OR "deep learning" OR "machine learning" .

6, 7 Search terms used for QUID database research: "artificial intelligence" OR "machine learning" OR "data science" OR "natural language processing" OR "image recognition" OR "computer vision" OR "deep learning" OR "analytics" OR "health informatics" OR "big data" OR "quantitative analytics" OR "quantitative computing" OR "reinforcement learning" OR "AI"OR "ML" OR "DL" OR "NLP" OR "RL."

8 Average 2019 USD-CAD exchange rate: 1.3269

9 Source: Deloitte research.

10 See endnotes 7 and 8 for search terms used.

11 Source: Deloitte research.

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