The Future of Artificial Intelligence

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How robots, artificial intelligence and machine learning will affect our lives, and the innovators behind the algorithms

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UNIVERSITY OF TORONTO
DRIVING EXCELLENCE IN MACHINE LEARNING & DEEP LEARNING

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Special thanks to the University of Toronto for assistance in the start-up of the Vector Institute

More artful than artificial: AI is already solving some of our most complex challenges

By Karen Mazurkewich, Editor, and Kara Collins, Managing Editor

Since artificial-intelligence software is encoded with the same basic 1's and 0's that have formed the building blocks of computer programs for decades, readers might ask, what makes AI “special”? What makes artificial intelligence more “intelligent” than, say, an old X-Box, or a gas-station microwave oven? And why all the hype?

AI is often confused with data analytics, but it’s far more complex. It’s a set of technologies that mirrors human intelligence, and augments it, by filtering vast inputs and options at speeds far beyond the computing ability of a human brain. Geoffrey Hinton, a world-leading AI expert and chief scientific advisor at Toronto’s Vector Institute, says programmers essentially teach computers how to solve a problem the way the human brain would if it could perform all the required computations: “You know the basic way to solve the problem. The computer is just doing the actual work.”

Since machine-learning involves much more than traditional computer algorithms, it promises to solve some of the world’s most complex problems – from identifying traces of diabetes in ophthalmological scans to turning speech into text.

It is also a field that attracts a wide-ranging professional population. For example, developing machine-learning technology to identify early symptoms of cognitive impairment may require the combined expertise of computer programmers, psychologists, geriatricians and speech-language pathologists. And because the needed data sets may exist only in the hands of governments, universities or large corporations, these projects typically require collaboration among them all.

In 2000, long before the machine-learning technology revolution came of age, MaRS Discovery District was conceived as a hub where such forms of scientific and institutional cross-pollination would happen every day, across many different fields. With 1.5 million square feet of lab and office space, and a curated mix of diverse tenants, MaRS is the ideal platform to support multi-disciplinary discoveries. And its location in the heart of Canada’s biggest city, next to where University of Toronto researchers have created many breakthroughs in AI, has already proven critical to forming one of the world’s most productive and renowned centres for machine-learning incubation.

The pace of progress in the field of machine learning has been stunning. Many Canadians may be surprised to learn how many facets of their lives have already been affected by AI. In the articles that follow, MaRS and the University of Toronto have teamed up with Toronto’s top AI institutes to give you an overview of these exciting developments, as well as an introduction to a few of the leading researchers and entrepreneurs whose work we support.
When we talk about the benefit of diversity to our society, we often speak in general terms. But spend time with the entrepreneurs fueling the remarkable surge in artificial-intelligence (AI) research and development now taking place in Toronto, and the benefits of diversity become apparent in concrete form.

At a recent University of Toronto Rotman School of Management event showcasing business opportunities associated with the latest advances in AI, I saw venture demos from dozens of promising startups, all amid a crowd that was strikingly diverse even by Toronto standards. These things are awkward to quantify. But here’s a random sequence of attendee surnames based on a scan of ID cards at the reception desk: Adejouwo, Ehrsam, Conde, Pal, Lepshokova, Dhamani, Kurian, Ing, MacGregor.

Of course, the Canadian technology sector has been benefiting from diversity for...
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When I’m recruiting new talent, one of my big selling points is that Toronto is simply a fun, lively place to work and live. — Richard Zemel

$300K
Salaries commanded by highly sought-after AI experts in today’s competitive market

the University of Toronto and the research director of the new Vector Institute for Artificial Intelligence. As The New York Times recently reported, experts in the AI field can command salaries upwards of $300,000 U.S. in a fierce global market. And Zemel often finds himself face to face with candidates who just as easily could decamp to Carnegie Mellon University in Pittsburgh, or the Berkeley Artificial Intelligence Research Lab in California. Sometimes, geography acts as a trump card: “When I’m recruiting new talent, one of my big selling points is that Toronto is simply a fun, lively place to work and live.”

Toronto is still dwarfed by Silicon Valley when it comes to leading the digital revolution more broadly — especially when it comes to enormous, well-established brands such as Apple and Facebook. But the nature of AI technology allows relatively small companies to create highly profitable, technologically ambitious projects. Many of those companies are putting down roots in Toronto.

Diversity is key, both in coding and research
And while abstract issues such as diversity and inclusion may seem removed from the nuts and bolts of AI coding, Zemel’s own research suggests otherwise. While he spends much of his time working on core mathematical issues associated with AI, he also now is focusing on ensuring that new technologies exhibit what he, in one research paper, calls “algorithmic fairness” — so that machine-learned algorithms do not unconsciously embed racist or sexist suppositions into “the setting of insurance rates, the allocation of police, the targeting of advertising, the issuing of bank loans, the provision of healthcare [or] the admission of students.”

Many of the brightest stars in AI are young, with careers that began during the current AI boom. (At the Rotman event, I spoke with DarwinAI founder Alexander Wong. When I mentioned that he looked quite young, his colleague Mohammad Jarabou responded that Wong already has published more than 400 refereed journals and conference papers in computational imaging. AI and related fields. Moments like this happen all the time in this field.) But some veterans I spoke to stressed that today’s success began with far-sighted policies implemented decades ago.

According to Philippe Beaudoin, co-founder of Montreal-based Element AI, the Canadian Institute for Advanced Research is “one of the big reasons Canadian researchers developed AI.” A publicly organization that many Canadians may have never heard of, CIFAR encourages networks of researchers on high-risk, high-reward ideas, even if the ideas have no immediate payoff,” Beaudoin says. “In the case of [AI], some of these projects were cutting against the grain of the academy, where there was a lot of skepticism of this technology. It’s also a great example of why this kind of diversity — diversity in research — is also important,” he adds. “Government shouldn’t just fund one set of projects. You have to invest in a lot of different fields, because you never know. And if Canada is going to keep its AI advantage, we’re going to have to keep investing in fundamental research, and in our students, and in making sure our companies are early adopters of the latest technology. That doesn’t mean just developing tech, but applying it, too.”

To understand why the last five years have been a particularly exciting time in AI, and why Toronto has found itself at the centre of it, there’s no better source than University of Toronto professor emeritus of computer science Geoffrey Hinton. He is a legend in the field, thanks to his pioneering work in our understanding of neural nets, which comprise the basis for modern forms of what now is known as “machine learning.” Hinton has been working in the field since the 1970s. But it wasn’t until the mid-2000s that computer hardware was sufficiently advanced to perform the trillions upon trillions of iterative computations required to implement his models. In 2006, he and Ruslan Salakhutdinov, a University of Toronto colleague at Carnegie Mellon since 2009, led a scientific breakthrough that opened the floodgates to many of the machine-learning applications we now take for granted, such as accurate speech and image recognition. For non-specialists, it’s difficult to understand the significance of this moment. Suffice it to say that their ground-breaking work, summarized in a Science article titled Reducing the Dimensionality of Data with Neural Networks, helped to solve one of the foundational problems associated with many neural networks. “People were tremendously excited,” Hinton recalls. “But there were no big, major practical breakthroughs until it became implemented in speech-recognition. You may remember in 2012, when suddenly Android software could understand you much better. A lot of that technology pretty much came right out of the work my students did right here at the University of Toronto. And it showed that neural nets were the way to go for speech recognition — and a lot of other things, too.”

It was an amazing moment in Canadian science, even if it was not widely lauded as such at the time. Hinton, who had been proselytizing neural nets for three lonely decades, all at once saw his brainchild put to use in technology gadgets that billions of people around the world carry in their pockets.

Now 69, Hinton is still at work, developing new neural network technologies aimed at further streamlining and improving machine-learning processes. Among his colleagues at the University of Toronto and the offices of Google (he splits his time between the two), he is an intellectual celebrity. Yet, when he steps outside for lunch, few Torontonians recognize him. Which is ironic, given Toronto’s historic obsession with its place in the pantheon of “world-class” cities. For, in the long run, the AI technologies that Hinton and his colleagues created and developed at the University of Toronto may do more for the city’s growth, prosperity and reputation than Drake, Auston Matthews and Joe Carter put together.
AI kicks the life-saving drugs, cheaper, faster, and more cheaply, it can deliver drugs more quickly of treatments, AI can not only cause of a disease, and rapidly genetic mutations at the root enhance it. By finding the accelerate this process—and cost billions.

Deep Genomics is applying this “intentional” approach to rare Mendelian disorders, a class of inherited diseases that result from a single genetic mutation, so they are considered relatively simple for scientists to target. Although rare, there are many such disorders; indeed, they are estimated to affect 350 million people around the world. One example, spinal muscular atrophy, is a leading cause of infant mortality, for which the U.S. Food and Drug Administration approved a new drug called SPINRAZA in December 2016, despite the fact it was still in the final phase of clinical trials. Even with the FDA fast-track, the drug took 13 years to develop, and it costs patients $750,000 U.S. in the first year, then $375,000 annually for life. Frey suggests the use of modern technology, including AI, can reduce both the time frame and cost. “At Deep Genomics, the hope is to make better medicines available to more people, more quickly.”

As well as rare diseases, AI is on the trail of mass murderers: the Ontario Institute for Cancer Research is using machine learning both to develop genomic tools for early cancer detection and to categorize tumours, so clinicians can devise more effective treatments, says Philip Awadalla, director of computational biology at OICR. “There’s a lot of data to be mined that have been under-exploited or under-utilized,” he explains, and OICR has access to mountains of it collected both by the Ontario Health Study, its landmark attempt to help researchers better understand the environmental, lifestyle and genetic factors that cause cancer and other chronic diseases, and the International Cancer Genome Consortium, a global agency based at the institute. Analyzing all this information could bring to light, for instance, compounds that are used for one condition that could be applied to another.

As for drug discovery, says Awadalla, who also teaches and medical genomics at the University of Toronto, AI can speed up the assessment of new compounds for their effectiveness, toxicity and ability to be metabolized. Researchers use “pre-existing data to predict potentially new interactions,” he says, which screens out molecules with undesired effects and prioritizes more effective ones. This process takes seconds or minutes using high-speed computing, compared with months and years of experimentation. But the process doesn’t stop there, he says. It is still necessary “to take something into the lab, and you still need to go through the various steps of clinical trials. Sometimes there is something to be said for approaches that may be more traditional.”

AI is only one part of the drug-discovery model. What researchers need is a hybrid, according to Naheed Kurji, president and CEO of Deep Genomics, a Toronto startup that specializes in genetic medicines. “If you talk to experts,” he says, “you find that it’s not possible to imagine a future of medicine without AI.”
Digital diagnosis

Machine-assisted medicine is so good at figuring out what ails you that frail patients need not undergo arduous tests and Alzheimer’s disease no longer comes as a surprise.

By Jonathan Kay

To understand the revolutionary innovations in medical technology being unleashed by artificial intelligence, it’s useful to start with the lives — and deaths — of two legendary actors: Paul Newman and Gene Wilder.

They both died, eight years apart, at the age of 83. While Newman kept up an active public life until shortly before his death, Wilder spent his final years in seclusion. Only later did his family reveal that he had suffered from Alzheimer’s disease.

Wilder was able to keep that fact private, but AI-powered technology developed in Canada now makes it possible to analyze interviews he recorded, from the early 1970s onward, and chart linguistic symptoms associated with cognitive impairment. For instance, as the years went by, he tended to use shorter noun phrases and fewer clauses per sentence. He also swapped out nouns for pronouns with greater frequency.

By contrast, analysis of Newman’s interviews over a similar period does not reveal such a pattern. He died in 2008, with no signs of cognitive impairment.

The comparison of the two screen stars was conducted using software created by WinterLight Labs Inc., a startup based out of the JLABS incubator in Toronto that brings together experts in speech, neurology and computer science. Using machine learning — a subset of AI that allows computers to self-construct decision-making algorithms through the recursive analysis of banked data — WinterLight’s software parses recordings for hundreds of characteristics, including the length of pauses, the types of verbs that are used, irregular frequency and loudness, changes in vowel acoustics, reduced syntactic complexity and instances of repetition.

**AI-powered systems could give advance warning of illnesses**

Each variable, taken in isolation, may have little or nothing to say about a patient’s cognitive state. But when all are processed through a matrix that incorporates a mathematical model of their inter-relationship, the system can alert caregivers to markers for Alzheimer’s or Parkinson’s disease, as well as depression, multiple sclerosis and schizophrenia — sometimes years before a patient exhibits overt symptoms.

In one 2016 study, co-authored by WinterLight co-founder Frank Rudzicz, the approach achieved more than 80-per-cent accuracy in distinguishing individuals with Alzheimer’s. Computer scientist Kathleen Fraser, also a WinterLight founder, has applied similar tools to achieve almost perfect accuracy in detecting patients with primary progressive aphasia, another degenerative neurological disease.

WinterLight has been enlisted in pilot projects at senior-care homes operated by Revera, VHA Home HealthCare and Shannex, as well as in clinical trials conducted by two large pharmaceutical companies. In so doing, its scientists have come to understand that accurate results aren’t enough: The science has to be presented in a way that patients and caregivers find useful.

“People want to know why our software produced a certain result,” says chief executive officer Liam Kaufman. “You have to explain what behaviours were measured. It isn’t enough just to provide the numerical output.”

WinterLight has yet to receive approval from regulators to market its software as a diagnostic medical device — a process that can move much more slowly than the creation of new software technology. But Kaufman and Rudzicz are optimistic.

**Computers already outperform medical professionals in some kinds of diagnostic tests**

The use of machine-learning technology to assist in medical investigations isn’t new. Computers now outperform dermatologists in scanning lesions for skin cancer. And a Stanford-led group has created an algorithm that trumps cardiologists in detecting heart arrhythmias on the basis of electrocardiograms. But these approaches represent an extrapolation of existing consumer-oriented technologies — such as facial recognition and photo classification — that focus on a single diagnostic artifact. WinterLight exemplifies the ongoing expansion of this machine-learning approach to broader and more complex types of inputs.

A product developed by Analytics 4 Life Inc., another startup based out of the JLABS incubator in Toronto, illustrates the same ambitious approach. The company’s CorVista device and software package applies machine-learning techniques and three-dimensional imaging to detect coronary artery disease (CAD) on the basis of skin-surface electrode measurements and other physiological data. The technology is still being tested in clinical studies. But the ultimate goal, says Shyam Ramchandani, vice-president of clinical affairs, is to allow doctors to investigate the presence of CAD without subjecting patients to radiation, injections or exhausting clinical therapies.

“Existing diagnostic techniques in this area typically require the
significant improvements in the way patients receive care. During a presentation this past summer, Anna Goldenberg, an assistant professor of computer science in the University of Toronto’s computational biology group, described the rigorous oncological monitoring regime required by sufferers of Li-Fraumeni syndrome, a hereditary condition that compromises the body’s ability to suppress tumours. This regime includes regular full-body MRI scans, which are stressful for adults, and sometimes almost impossible for young children, who cannot lie still for the duration of the test.

Responding to this challenge, Goldenberg and her colleagues used machine-learning software to identify those Li-Fraumeni patients most likely to be diagnosed with cancer before age 6. Already, her non-invasive AI-powered surveillance model is approaching the accuracy level of traditional diagnostic methods, all without the associated cost and trauma.

Goldenberg’s presentation was titled Will Dr. Robot Ever See You? It’s an apt question: Like all modern workers, health providers and researchers are grappling with how much of their professional role in our society will migrate from human agency to computer algorithm. While doctors once were assumed to be largely protected from the trend toward automation, that is changing: As machine-learning technology is used to automate the search for symptoms of diabetic retinopathy in eye scans, for instance, we may one day need fewer ophthalmologists.

Some of the new technologies also may change the relationship between patients and caregivers — sometimes in unsettling ways. For example, WinterLight’s software may lead some patients to fear that every word they utter will be scrutinized for evidence of mental deterioration.

“I wonder about the dynamic between the nurse and the patient,” says Samir Sinha, director of geriatrics at Mount Sinai Hospital in Toronto. “When people are losing their memory, they get paranoid, they get anxious. They get upset and depressed — because they know that this can be used as evidence to take away their freedoms. And if you start co-opting human communication, a fundamental way that people get pleasure and companionship, they might just keep their mouths shut.”

Liam Kaufman, WinterLight’s CEO, has thought about such issues. “White coat syndrome is a real problem, and not just with cognitive assessment,” he acknowledges. “Just going to the hospital, it turns out, can make your blood rate go up.”

But in his view, much of the stress arises from the irregular, high-stakes nature of medical visits. “Right now, someone may go to the hospital once per year — and they stress out and clam up. Our theory is that, by doing your assessment in the comfort of your own home, and by doing it frequently — every few months — it becomes a habit. And the stress actually goes down.”

Because this technology is new, both patient-response theories are untested. But these issues will need to be explored, as AI-enabled tools take a more prominent place in our health systems. In geriatrics, as in most areas of medicine, the future likely will take the form of a partnership between the old and the new, humans and machines — with doctors informing their judgment on the basis of improved diagnostic analysis, without alienating patients in the process.

injection of radioactive dyes and other contrast elements into a patient’s bloodstream,” Ramchandani explains. The whole process is uncomfortable, and can take many hours. And only a small percentage of these people even need treatment. “We’re creating a gentler option.”

Machine-learning diagnostics could sometimes be the kinder, gentler option

In pediatric medicine, in particular, the less invasive and less arduous diagnostic strategies facilitated by machine learning will offer
The feeling of dread is nearly universal in our credit-addled society. Even as bills pile up and that retirement fund demands care and feeding, temptation rears its head — a pricey outfit, an impulse weekend in New York, that new iPhone. Some of us are highly disciplined when it comes to managing our finances, but others avoid the math and end up overdrawn, if not deeply in the red.

ATB Financial, an Alberta credit union, recently launched ATB Trackit Mobile, a smart-phone-based personal banking assistant whose artificial intelligence (AI) technology effectively allows customers to outsource the management of their cash flow to an app. Designed by Vancouver-based startup Finn.ai, the assistant automatically performs such tasks as creating budgets, tracking debt and sequencing payments by making predictions based on the customer’s spending and saving habits so they avoid bounced cheques or overdrafts.

According to Jake Tyler, chief executive officer at Finn.ai, banks may benefit because their sustainably solvent customers will have more savings since they can better gauge how much consumer debt they can handle. Tyler believes they’ll also gain a greater sense of brand loyalty, pay less in interest and avoid over-draft fees. “Every bank in Canada is looking at how to deploy part of what we’re talking about,” he says. “We’re going to see the market move quite quickly.”

Such partnerships illustrate how some fintech firms are increasingly inserting themselves into the space between financial institutions and their customers, many of whom now do much of their day-to-day banking on mobile phone apps with relatively limited functionality. Others are going a step further, grabbing ever-larger chunks of the consumer-lending business.

Without AI, banks could move quite quickly.”

Challenged by nimble startups, Canada’s big banks are embracing AI, both to cut costs and compete. From chatbot service reps to predicting what will go viral online, the changes will be staggering.

By John Lorinc

The Future of Artificial Intelligence

Smart money

By Foteini Agrafioti, head of Borealis AI and chief science officer of RBC, in the Borealis AI office space

IMPROVING THE CUSTOMER EXPERIENCE

For example, Jordan Jacobs, co-founder and CEO of Toronto AI firm, Layer 6, says the lumbering sector has done much in recent years to meld pools of customer data gathered from savings accounts, mortgage and lending operations, and portfolio management. “Banks have spent a fortune building those data lakes,” he says. “But they’re incapable of doing anything predictive with it.”

Layer 6 is marketing a set of algorithms that continuously scan customers’ interactions with banks for patterns to help predict how they will react. As Jacobs explains, if a customer has just had a negative experience – such as a conflict with a call-centre service rep over a credit-card transaction – the system can serve up measures meant to improve that customer’s next encounter, and thus seek to ensure the person doesn’t switch banks.

Yet, despite Jacobs’ skepticism, most Canadian banks are investing in AI capabilities, either directly or indirectly. This year, former TD Bank CEO Ed Clark was instrumental in setting up the Vector Institute, a partnership between government, institutions like the University of Toronto, and the private sector to advance AI research, and drive its application, adoption and commercialization. Located in the MaRS building, Vector’s public support comes from the Ontario government (cont’d on page 15)
Banking on AI

Why does Canada, a leader in AI research, fall behind when it comes to creating marketable products? Often, it’s because our best and brightest head south. Banking giant RBC aims to change that, luring talent back with the promise of big datasets and greater research freedom.

BY DAVID PATerson

B orealis AI is billed as half theoretical academic research institute, half applied machine learning space. But it looks all startup. There are basketball hoops, exposed brick walls and a meeting room where the benches and table slide on tracks. Sparkling Italian sodas are the drink of choice among the staff, and they keep a bread selection on hand.

Aside from a familiar lion and globe logo on the phone screens, there’s nothing to indicate that Borealis AI is actually an offshoot of one of Canada’s oldest companies, banking giant RBC.

From their space on the third floor of MaRS, an innovation hub in downtown Toronto, Borealis AI’s 35 staff are trying to apply the vast analytical abilities of academic research but lag countries like the U.S. and U.K. in turning those discoveries into marketable products?

Graham Taylor, an associate professor in machine learning at the University of Guelph, says that American investors were quicker to spot the potential of AI and began pouring money into the sector much earlier than in Canada.

Until recently, a brain drain of Canadian graduates headed south of the border sapped this country’s ability to commercialize breakthroughs. According to Fotini Agrafioti, a brilliant researcher and former startup founder tapped by RBC to head Borealis AI, Canada was in danger of losing so much expertise and intellectual property, it would have been unable to catch up. Foreign companies would profit from commercializing research paid for by Canadian taxpayers – an unsustainably expensive proposition.

“Research cannot be the destination,” says Agrafioti. “Academic research is funded by the resources of this country, so it has to give back and generate wealth for the Canadian population.”

In the past year, major investments from the public and private sectors, such as the Vector Institute and a potential AI innovation “supercluster” in Montreal, have helped reverse the flow of talent. Borealis AI’s lure for in-demand talent is the offer of a much broader degree of research freedom than they would get working for a product-focused tech firm, along with access to the computing resources and enormous data sets of Canada’s biggest company.

Staff pursue a mix of curiosity-driven fundamental research and applied machine learning projects. Engineers are encouraged to collaborate with universities and startups, and share their results with the scientific community.

As competition for talent intensifies, organizations will face growing pressure to allow their research-minded staff to rove between the theoretical and practical in their work. Taylor says that AI graduates want to work in places where they won’t be chained to constant product development.

“One of the ways to keep people is [to create] these open source and open publication models, because that’s the kind of environment they look for and want to work in,” he says.

If these models succeed, they should help reverse the flow of talent. From their space on the third floor of MaRS, an innovation hub in downtown Toronto, Borealis AI’s 35 staff are trying to apply the vast analytical abilities of academic research but lag countries like the U.S. and U.K. in turning those discoveries into marketable products.

Fotini Agrafioti, head of Borealis AI and chief science officer of Kasisto, a machine-learning spinoff of the famed Stanford Research Institute (SRI) in Silicon Valley, believes that the future of AI lies in developing algorithms to shape and adjust portfolios according to changing market conditions. Jacob’s of Layer 6 notes that, eventually, machine learning will affect everything from general internal applications – such as hiring – to the huge volumes of work involved in investment banking. One example: algorithms capable of evaluating large numbers of research papers and commercial contracts as part of the due diligence process. Traditionally, Jacobs observes, such work is done by teams of lawyers and auditors, which are expensive, as well as costly.

Banks are also edging cautiously into AI-driven business,” she explains. Agrafioti’s team of computer science and engineering PhDs is also conducting fundamental and applied academic research on various aspects of machine learning science, with an eye to developing applications in fraud detection and cybersecurity.

Robo-advisors will automatically adjust your portfolio

Banks are also edging cautiously into AI for wealth management through low fee robo-advisors. So far, among bank-owned investment dealers, only BMO Neasbitt Burns has begun to offer such a service, known as SmartFolio. The field is dominated by independents such as Wealthsimple, a three-year-old Toronto “intelligent investment” startup backed by $100 million from Silicon Valley and Power Financial, a subsidiary of Quebec’s Power Corp.

These services, geared at younger investors, have not caught on as quickly as originally thought. Jenkins has jumped to fintech firms like Kasisto, a machine learning startup that has begun to offer such a service, known as SmartFolio. The field is dominated by independents such as Wealthsimple, a three-year-old Toronto, “intelligent investment” startup backed by $100 million from Silicon Valley and Power Financial, a subsidiary of Quebec’s Power Corp.

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Banks are also edging cautiously into AI-driven business,” she explains. Agrafioti’s team of computer science and engineering PhDs is also conducting fundamental and applied academic research on various aspects of machine learning science, with an eye to developing applications in fraud detection and cybersecurity.

Robo-advisors will automatically adjust your portfolio

Banks are also edging cautiously into AI for wealth management through low fee robo-advisors. So far, among bank-owned investment dealers, only BMO Neasbitt Burns has begun to offer such a service, known as SmartFolio. The field is dominated by independents such as Wealthsimple, a three-year-old Toronto “intelligent investment” startup backed by $100 million from Silicon Valley and Power Financial, a subsidiary of Quebec’s Power Corp.

These services, geared at younger investors, have not caught on as quickly as originally thought. Jenkins has jumped to fintech firms like Kasisto, a machine learning startup that has begun to offer such a service, known as SmartFolio. The field is dominated by independents such as Wealthsimple, a three-year-old Toronto, “intelligent investment” startup backed by $100 million from Silicon Valley and Power Financial, a subsidiary of Quebec’s Power Corp.
Cleaner, greener... and smarter

From heating homes and trading electricity to boosting wind power production and keeping pipelines safe, machine-learning algorithms and big data are giving the energy sector a serious boost

By Tyler Hamilton

When Ontario’s energy ministry launched its “green bank” this past summer to help homeowners and small businesses become more energy efficient, one of its first actions was to give away and install 100,000 smart thermostats.

On the surface, it seemed like an expensive publicity stunt. But dig a little deeper and the campaign, with its $40-million price tag, is arguably one of the biggest efforts in Canada to give artificial intelligence (AI) a foothold in the home.

Chances are, the thermostat hanging on your wall right now isn’t much of a thinker. It turns on and off when you tell it to, but doesn’t really “know” anything about you. It doesn’t sense and react to its surrounding environment.

Smart thermostats, on the other hand, are always learning. These clever devices, like models sold by Toronto-based startup Ecobee or Google-owned Nest, never stop collecting data on local weather, and they’re constantly taking note of when we come and go from our homes. They track the times we go to bed and wake up and, with the help of occupancy sensors, know which rooms we tend to use most and when we typically use them.

The more data that flows into these wall-mounted gadgets, the more accurate they get. Using machine-learning algorithms to tune into our changing routines and behaviours, they use the least amount of energy possible to keep us comfortable in our homes.

Big changes coming to the electricity sector

It’s just a small taste of how AI is starting to transform our relationship with energy as we make the transition to a low-carbon economy — from how and when we produce, deliver, store and even trade it. The impact will be felt most in the electricity sector, which is expected to become more efficient, reliable, secure and safe as AI algorithms play more critical roles in an increasingly complex show.

“It may lead to a world where power generation, distribution and transmission operations are automatically optimized, where the grid is balanced independently of any human interventions, where trading and arbitrage decisions are made in nanoseconds at a scale that only machines could tackle, and where [customers] never have to worry about searching for a better supplier or changing the temperature manually,” McKinsey, the international consulting firm, envisioned in a discussion paper last June.

It’s unclear when the power grid will no longer need humans, but AI is already having a measurable impact. General Electric says it can boost energy production from wind farms by as much as 20 per cent using machine learning to anticipate and better respond to wind direction and speed, and to monitor wear and tear on parts, allowing for proactive maintenance. Google has slashed 15 per cent from its power bill by employing AI alongside a network of data-collecting sensors to make better use of fans, cooling systems and other equipment in its data centres.

AI will turn your electric car into a power broker

Own an electric car? If companies like Microsoft and GE have their way, AI could one day be your own personal power broker, watching the electricity market and charging your vehicle only when the price is low or the wind is blowing; then selling the electricity in your car battery back to the grid when it can fetch a higher price (and you don’t need it). For car owners, it saves money — and sometimes makes it. For utilities trying to reduce fossil-fuel use, particularly during periods when electricity is in high demand, it’s a way of harnessing an expanding network of vehicle batteries to create virtual power plants that automatically spring into action when needed.

Toronto-based Kelvin Thermal Energy is pursuing similar AI capabilities for big industrial customers that want to store cheap electricity as heat inside graphite blocks, and then extract that energy when it’s most needed. “It’s important that we have the ability to take, and stop taking, electricity when it’s most advantageous for the customer, so we’re leveraging all the great work that’s going on in AI and predictive analytics to achieve that,” says Stephen
Energetic startups
Three cleantech startups that are cleaning up thanks to AI

By Tyler Hamilton

Three cleantech startups that are cleaning up thanks to AI

Thermo.AI
Machine-learning algorithms help Thermo.AI create the conditions where power plants can convert fuels into energy more efficiently. The company is experimenting with power-grid operators and even power plants to test the conditions for complete combustion of such fuels as coal or natural gas. Based in New York, the company employs special sensors to analyze moisture content in fuel, atmospheric pressure, interaction with air and other factors, making adjustments as necessary to ensure the perfect burn.

AI helps customers get more energy out of their fuel, which not only reduces carbon emissions but extends the life and lowers maintenance costs of equipment by reducing wear and tear. Co-founder and CEO Carolina Chaves Gonzalez says the best way to make a huge impact is to make our current energy infrastructure more efficient.

EnergyX Solutions
Based in Burnaby, B.C., the company aims to use AI to accelerate development plans.

A major challenge is understanding how to create a controlled fusion reaction with plasma fuel. That means running simulations of how plasma behaves under a seemingly infinite combination of operating conditions and variables. Here, AI algorithms are being used to speed up analysis of simulations and even reduce the number of simulations required.

Chief Technology Officer Michael Delage says it allows General Fusion to optimize its processes and reactor settings faster than ever. "These tools are extremely important is to make our current energy consumption for customers."

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One reason that racism, sexism and all the other “isms” are so pervasive in society is the fact that they are not necessarily intentional: nearly everyone is guilty of unconscious bias.

Psychologist Timothy Wilson, who teaches at the University of Virginia, says that we are constantly exposed to millions of bits of information, but the brain can process only 40. To cope, “it creates shortcuts and uses past knowledge to make assumptions,” he told Fast Company magazine in 2014. In other words, our experiences and our culture can influence how we assess others, and we don’t even realize it.

Why your résumé isn’t giving you a foot in the door
Artificial intelligence can help solve the problem by providing a bias-free screening tool. This saves employers valuable time that they can use to fill the positions they need. Which everyone is guilty of unconscious bias.

One of the main determinants open-minded can’t fight brain science, according to psychologist Timothy Wilson. Wilson, who teaches at the University of Virginia, says that we are constantly exposed to millions of bits of information, but the brain can process only 40. To cope, “it creates shortcuts and uses past knowledge to make assumptions,” he told Fast Company magazine in 2014. In other words, our experiences and our culture can influence how we assess others, and we don’t even realize it.

MacGregor, chief executive officer of Plum, is a Kitchener-based company with a different approach to applicant screening. In fact, she says, résumés introduce a whole slew of biases — where the applicant went to school, past experience, name, gender. Only when “you don’t use that as your short-listing factor” do you have a set of criteria “that matters.”

Plum, like Knockri, works closely with clients to identify what they are really searching for in a job candidate. These qualities are programmed into the AI, and job seekers are filmed as they respond to questions that have been formulated with the help of psychologists to tease out whether they possess the desired qualities.

For each question, Knockri allows 10 seconds of prep time and 45 seconds to provide an answer that is analyzed with IBM AI, as well as the company’s own proprietary technology, which examines muscle movements. Videotaping may reveal a person’s gender and race, but Ansari explains that they, like sexuality, are not considered “desirable measures.”

The motion technology, he adds, “just sees facial muscular contractions and analyzes tonality and style of response.” It will register whether an applicant grimaces when talking about a previous boss, for example, and can detect undertones of aggression or enthusiasm, providing information that can be more meaningful than entries on a résumé.

AI as job matchmaker
Obviously, all of these features benefit whoever is doing the hiring, but it could also benefit applicants, helping them avoid altogether a job for which they’re simply a bad fit. There is evidence that as many as 70 per cent of workers may be in positions for which they are not well suited.

To Jamie Schneiderman that is a “huge problem” and it’s one of the reasons why he launched Toronto-based Clearfit Analytics. “We set out with a mission to get people into the right jobs,” he says, adding that the end result is “happier people and a more productive company.”

Schneiderman knows from personal experience how important personal satisfaction can be. After earning a master’s degree in business administration from Harvard, he worked with some large, well-known companies but “I found my career unbelievably frustrating.”

Neither employers nor employees, he adds, want to make poor decisions, but avoiding them requires that they do things differently. Clearfit uses artificial intelligence to play matchmaker. Every applicant and job seeker sends a shortlist of candidates to the company she has worked with 5,000 companies in the past 10 years and collected data on 1.5 million people) answers a series of questions. “Then our system can combine people together to build ‘success profiles’ on a role-company—industry basis,” Schneiderman explains. “I can take a person who’s applying to a company and automatically match them with the job for them.”

AI helps employers truly see their candidates
Also, like Knocki and Plum, Clearfit says its process increases diversity because applicants are shortlisted strictly on the basis of how they perform during the screening.

“Of course, when humans do things differently, there is no point in promising to remain as objective as possible.”

The potential catch, then, is that AI still depends on the humans who input the data. The companies using it say they strive to ensure that their criteria remain as objective as possible. There is no point in promising to find the best person for the job if something as simple as Jahanzaib Ansari is disqualified simply because of his name.

R.I.P. résumés
AI-assisted screening of job applications reduces sexism, racism and ageism in the workplace
By Nora Underwood

Four years ago, much to his mother’s chagrin, Jahanzaib Ansari dropped out of university to pursue his entrepreneurial dreams. His first effort, a bespoke facial recognition system, didn’t pan out, he went to Toronto and joined the ranks of tech startups. Then he came across studies showing that members of minority groups were more likely to get a second look. Jahanzaib became Jay, and “I got so many job interviews, I was astounded.”

One of them paid off, but not for long. Disappointed at what he’d had to do just to get the job, Ansari decided to leave it and try to change the system. He and two partners founded Knockri, and joined the ranks of those now using cutting-edge technology to help employers find the best person for a job — without bias getting in the way.

One reason that racism, sexism and all the other “isms” are so pervasive in society is the fact that they aren’t necessarily intentional: nearly everyone is guilty of unconscious bias. The motion technology, he adds, “just sees facial muscular contractions and analyzes tonality and style of response.” The short list of candidates will register whether an applicant.
The very real ways that artificial intelligence is reshaping medicine

A Q&A with Dr. Guna Rajagopal, Ph.D., Global Head of Computational Sciences, Discovery Sciences, at Janssen Research & Development

Artificial intelligence presents boundless opportunities to transform human health. Already, it’s aiding in the discovery of new drugs and helping to create better, faster medical diagnostics. It’s not difficult to imagine a time in the near future when AI is able to reliably predict and intercept disease before symptoms ever arise.

However, with so much hype surrounding AI, it’s easy to forget that we’ve only scratched the surface in understanding what’s possible with machine learning, and it may be applied to healthcare, says Guna Rajagopal, Ph.D., Global Head of Computational Sciences, Discovery Sciences, at Janssen Research & Development.

Dr. Rajagopal leads a team of data scientists who are using high-performance computing to assist in the creation of new drugs and healthcare products. He’s also currently working with Johnson & Johnson Innovation, JLABS to evaluate nominees to the Artificial Intelligence for Drug Discovery QuickFire Challenge, which will award up to $100,000 in grants and one year of JLABS residency to individuals or teams with the best ideas for using artificial intelligence to advance healthcare.

With the excitement of the QuickFire Challenge selections looming (expect an announcement in mid-December), we spoke with Dr. Rajagopal to learn more about how AI is changing the future of medicine.

Q. Artificial intelligence means different things to different people. How do you define AI, especially as it relates to healthcare?

A. AI is the science of building and programming a machine that’s able to imitate human cognition. The machine can learn from experience and generalize, which is where the intelligence part comes in. Most of us already interact with AI in our daily lives, whether it’s Amazon giving us personalized suggestions of products we might like, to real-time alerts of potential credit card fraud. Regardless of the industry, the purpose of AI is to guide humans to make informed decisions based on enormous amounts of data. As it pertains to healthcare, this data may include an individual’s genetic and environmental factors, activity trackers and bio-sensors, blood samples and electronic health records. The amount of health and genomic data that we’re generating is growing exponentially every year. While our AI tools are improving by the day, we also have to recognize that big-data research is still very much a nascent field. We have a lot to learn.

Q. What is some of the biggest transformations that AI will bring to healthcare?

A. It’s impossible to predict all the ways that AI will change medicine over time, but I believe it will be truly fundamental and sweeping. I’ll defer to the famous quote from American futurist Roy Amara: “We tend to overestimate the effect of a technology in the short run and underestimate the effect in the long run.” This is true of AI, just as it has been for other transformational technologies. If you look at the impact of AI for healthcare, you have to consider not only how it relates to the development of new medicines and faster clinical decision-making, but also elements such as pharmacy and supply chain — how we optimize our resources to get the right products to patients most efficiently.

Q. Precision medicine just may be the healthcare buzzword of the decade. How might AI impact the development of drugs that treat patients in a more precise way?

A. We’ve only begun to realize the benefits of precision medicine to treat disease, with notable early successes in cancer. The underlying idea is that we can use patients’ personalized information, such as genetic or molecular profiles, to determine what treatment approaches will work best for them as individuals. As we move forward, our success in advancing precision medicine will depend not just on collecting and storing vast datasets on diverse patient populations, but also on our ability to develop sophisticated machine-learning algorithms that can mine this data to answer specific healthcare questions. We see AI as a tool to help us analyze these factors and bring clarity to patients earlier in the process.

Q. In the latest QuickFire Challenge for Johnson & Johnson Innovation, JLABS, you’ve put a call out for entrepreneurs and innovators that are using artificial intelligence to advance drug discovery and development in some way. What do you hope comes as a result of this type of competition?

A. Even though Johnson & Johnson is among the world’s largest healthcare companies, we realize that we can’t do it all on our own. Our goal is to create an ecosystem of innovation around AI in healthcare, partnering with the best and thinking holistically about how solutions can be applied to various aspects of drug development and patient care. If you think end-to-end about our healthcare system — from the lab where drugs are created, to the patient’s bedside — the one thing that ties it all together is data. I’m optimistic about what AI can do to bring meaning to our growing pools of information, aiding in our ability to interpret diagnosis and treat disease.

What is possible vs. what is right

How far should we let AI go? There’s a growing campaign to make sure society comes out a winner

By John Lorinc

The transformative power of artificial intelligence has come to preoccupy big business and government as well as academics. But as AI’s potential sinks in, a growing number of policy experts — along with some leading figures in technology — are asking tough questions: Should these cutting-edge algorithms be regulated, taxed or in certain cases, blocked?

Consider what AI can do in the workplace. For example, managers realize that office politics, stress and other pressures take a toll on employees. They also know that standard-issue job-satisfaction surveys don’t provide a true gauge of what’s going on around the water cooler or in the staff lunchroom, says Jonathan Kranidier, Chief Executive Officer of Receptiviti.ai. To tap into more candid expressions of employee sentiment, his company, a three-year-old Toronto-based startup, has created an AI algorithm grounded in the research of James Pennebaker, a University of Texas social psychologist who has found that the way employees communicate with each other can provide insight into their behaviour and state of mind. So, the Receptiviti algorithms scans internal messages for particular words and expressions that Pennebaker says indicate dissatisfaction.

Anyone who works for a large organization will know their emails

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The Future of Artificial Intelligence | MaRS 23
An alarming loss of jobs has been predicted based on the implementation of AI-driven systems, including the replacement of everyone from call-centre staff to lawyers. Privacy isn’t the only source of friction, says Joe Crawford, a specialist in data analysis at MaRS Discovery District in Toronto. Other sensitive areas range from the quality of the data that is used by AI to what happens as robotic devices replace human beings. In the latter case, even Microsoft founder Bill Gates has suggested special taxes and a slower pace of adoption while authorities ask themselves “how can we use this technology (Asilomar is the conference where the summit took place).”

North of the border, the Canadian Institute for Advanced Research (CIFAR), which funds the newly established Vector Institute through the federal $125-million Pan-Canadian AI Strategy, promotes AI and has the additional mandate to investigate its social, legal and ethical implications, says Brent Barron, CIFAR’s director of public policy.

Barron says CIFAR is tracking the debates taking place within AI after it develops a policy framework for Canadian research and development, and will convene advisory panels to scope out what should be addressed. But he also says it’s “early days” and, for now, many AI startups will have to play cat-and-mouse with the evolving regulatory environment in jurisdictions across the country.

Kathryn Hume, vice-president of products and strategy for Toronto-based startup Integrate.ai, says her company has done this already. Founded less than a year ago, Integrate is testing a machine-learning system that draws from data pools maintained by large companies with extensive consumer bases. The algorithm is meant to come up with solutions that aim to optimize customer engagement.

The underlying idea – how can we keep our customers happy by analyzing data patterns – seems straightforward enough. But Hume points out that, when the algorithm also draws on the personal sources of data, such as credit scores, to develop conclusions, it immediately confronts questions about privacy and consent. Technically, she says, the company will erect a “mathematical wall” between the analysis and the underlying data – an emerging concept known as differential privacy – because it is seeking any patterns that data contains, not anything associated with any individual.

Despite those assurances, Hume points out, that since regions as the European Union, regulatory authorities have already begun to promulgate AI-related policies, such as right-to-know laws and policies mandating AI firms to be prepared to explain just how their algorithms generated particular outcomes.

At the moment, she says, the challenge for AI is to figure out what the implications of AI adoption outnumber the answers: “The legal community and the regulators have a lot of questions that aim to figure out what all this means.”

Guiding principles for AI

The Future of Life Institute says the Asilomar Principles, the following 23 measures to guide the advent of the intelligent machine, “offer amazing opportunities to help and empower people in the decades and centuries ahead.” Adopted by delegates to the institute’s annual gathering this year at the Asilomar conference centre in Monterey, Calif., they fall into three main categories:

**RESEARCH**

1. The intelligence created should be beneficial.
2. Investments should be accompanied by funding to ensure AI is used well, including such theory questions as how we can prevent systems from malfunctioning and increase prosperity while maintaining people’s resources and purpose.
3. There should be a constructive exchange between AI researchers and policy-makers.
4. A culture of co-operation, trust and transparency should be fostered among AI developers.
5. Teams developing AI should strive to work together and not cut corners on safety.

**ETHICS AND VALUES**

6. AI should be verifiably safe and secure, where possible.
7. If a system causes harm, it should be possible to ascertain why.
8. Any involvement by an autonomous system in judicial decision-making should provide a satisfactory explanation available to a competent human authority.
9. Creators of advanced AI systems must in use and misuse, and be responsible for its outcomes.
10. AI’s goals and behaviour should align with human values.
11. It should be compatible with ideas of human dignity, rights, freedoms and cultural diversity.
12. People should have the right to access, manage and control the data they generate, given AI’s ability to analyze and utilize that data.
13. The application of AI to personal data must not unreasonably curtail personal liberty.
14. AI should benefit and empower as many people as possible.
15. Prosperity created by AI should benefit all of humanity.
16. Humans should choose how and whether to delegate decisions to AI systems, to accomplish human-choice product-lives.
17. Rather than subvert, AI should respect and assist the processes on which a healthy society depends.
18. An arms race in lethal autonomous weapons should be avoided.

**LONG TERM**

19. We should avoid strong assumptions regarding upper limits on AI capabilities.
20. AI should represent a profound change in the history of life on Earth, and should be planned for and managed with commensurate care and resources.
21. Risks posed by AI, especially those that are catastrophic or existential, must be subject to planning and mitigation efforts.
22. AI designed to improve or replace itself rapidly must be subject to strict controls.
23. Superintelligence should be developed only in the service of the widely shared ethical ideals, and for the benefit of all humanity.
Can a computer write a great novel, paint a masterpiece? Not yet, but algorithms are beginning to prove very helpful in humanity’s quest for creativity. And it won’t be long, some predict, before they’re making that quest on their own.

By Gerry Flahive

Although AI can already produce poetry, pop music or movie scripts, “there’s the sense that something is fundamentally missing. In a way, the algorithm doesn’t really get it.” — Inmar Givoni

AI can see things that humans can’t

In the process, Project Discover, well, discovered, that a “generative” design system can see things we can’t. And because the algorithm “uses concepts found in natural evolution,” according to its creators, it also can ensure survival of the fittest, by “gradually promoting the best options” for serious consideration.

What Autodesk has done reveals the immense potential of using AI to turbo-charge the creative process: It can come up with a huge number of possible solutions, but then winnow them down to a practical number. By rapidly running through virtual prototypes of solutions, a learning machine becomes a kind of serendipity engine that powers creativity. But does this serendipity engine still need a driver?

The creative approach adopted by Project Discover, says Khan, has sparked “ravenous interest” in all sorts of applications of the software the project is to produce. He sees it being used “to optimize, for example, factory layouts, electronics designs and even entire neighbourhoods.” But AI-driven creation is far from a turnkey operation. There are still some big philosophical hurdles ahead. For one thing, what exactly is creativity?

AI might be productive, but does it get creativity?

Machine-learning specialist Inmar Givoni calls it “an abstract concept that is hard to nail down and properly define. It’s one of those things where we know it when we see it. Or more accurately, we think we know it when we see it.”

Givoni, who works for Kindred, a Toronto company trying to “enable robots to understand and participate in our world,” says that, although AI can already produce poetry, pop music or movie scripts, “there’s the sense that something is fundamentally missing. In a way, the algorithm doesn’t really get it.”

“It doesn’t understand what makes sense and what doesn’t, and when is it interesting to not make sense.”

Sanja Fidler at the University of Toronto says the advent of AI that “gets it” may just be a matter of time. The assistant professor of computer science and her colleagues have a program that generates pop music — they call it a “neural karaoke” — from photos, as well as another program focused on neuro-aesthetics (it can calculate what’s in fashion on the basis of thousands of clothing images from social media).

The future of storytelling

Now she is trying to determine if such neural networks can go “beyond the data you give them.” For example, “If you are asking AI to generate, say, 50 to 100 new stories based on data from thousands of books, what it creates is going to be somewhat biased because it’s taking stuff from that existing pool of information.” Because there is no AI that is “embodied” — able to “just go
Highly useful, but not creative.
practical realms, from refining Netflix
to expand its assistive reach into
quality, the imagination, AI continues
eンド a computer with that ethereal
Meanwhile, as scientists struggle to
happen — when machines can
be embodied AI agents that build
or data sets that a computer can
to be reduced to narrative patterns
human creativity – is too complex
says. Today, the story — perhaps
and kind of blend them together.”
Autodesk, called Project Narrativa,
and “rules” that Lucasfilm has to
overwhelming data sets, and carve
their creation, could benefit from
more than 80,000 entries.
Such ambitious properties,
and so many humans involved in
their creation, could benefit from
the all-seeing technology that is
to come, Koch says. AI could be a
valued partner "as we search along
a guided path through otherwise
overwhelming data sets, and carve
the story out of that big mass of
marble, the potential story that's
already in there." Before computers
can do anything creative with all
this information, he adds, "we need
to shape the data so that it is better
for humans to deal with.
He says the magic-botton allure of
AI doesn't cloud his faith in, and
passion for, the human creative
exchange. "What makes me tick is
that... creative spark, the handing
over of an idea, one person talking
to another." From that spark, "our
ideas multiply and build on one
another, and they become that
much stronger."
As long as the creative force is
liberated, Koch says, "I do not care
what technology is running behind
the curtain."
endless choices, "the role of the
creative, of the artist, has to change," he
says. "You are going to have to guide
the process. You need to prune this
decision tree at a very rapid pace, or it
could very much overwhelm you. How
are we going to behave in the presence
of too many possibilities?"
In other words, 10,000 machine-
generated screenplays aren't going
to advance the art of cinema, but Koch
can foresee using AI to develop what
he calls "the story-information model —
everything that you need to know
about your story."
An example: Television and cinema
are now home to hugely complex story
worlds — think of The Walking Dead
and its multi-platform spinoffs, or the
many layers of Star Wars productions,
now so dense with plots, characters
and "rules" that Lucasfilm has to
employ archivists just to keep track.
One of them is called the Keeper of
the Holocron, a database that now houses
more than 80,000 entries.
Global tech giants including Google,
Samsung, IBM, Uber, Amazon and
OpenText are investing in Ontario and
building AI research facilities here. In all,
Ontario has more than
200 AI and advanced software
companies working across the
economic spectrum, fostering
technologies that do everything
from teaching cars to think to
improving the analysis of medical
images and creating life-saving
therapies.
The Ontario government's $50 million
investment to help launch the Vector
Institute for artificial intelligence has
energized an already thriving sector
by signaling a strategic shift toward
driving the application, adoption and
commercialization of AI technologies
to complement the province's world
renowned AI research capacity.
"There's a long list of reasons why
leading technology companies are
choosing Ontario, including its low
corporate tax rates, universal
healthcare, open business immigration
policies and competitive salary costs," says Allan O'Dette, Chief Investment
Officer at the Ontario Investment
Office. "But the main reason
companies are setting up their AI
teams in Ontario is the same one
that made the province a technology
leader in the first place: its people.
Ontario has an educated and diverse
population with one of the world's
highest densities of AI talent."
The University of Toronto is often
credited with being the birthplace
of modern machine learning, and
researchers trained there have gone
on to head AI research labs at tech
giants such as Apple, Google and
Facebook. Each year in Ontario,
about 40,000 students graduate
from science, technology, engineering
and math (STEM) disciplines,
including from the University of
Waterloo's globally recognized
computer science programs.
With AI employment opportunities
having increased in Canada by
500 per cent since 2015, the Ontario
investment is growing an additional
$30 million in the Vector Institute to
work with post-secondary institutions
across the province to ensure the
potential pipeline can meet demand.
Within five years, more than 1,000
master’s students will graduate in AI
and related fields annually, alongside
a further 10,000 STEM graduates.
"AI is expected to add 14% to global
GDP by 2020 — the equivalent of
an extra $15.7 trillion, and the
province is positioning itself at the
forefront of the AI boom, supporting
industry to create new jobs and
preparing Ontarians for the move
towards a knowledge-based
economy," says O’Dette. “Ontario
will continue to bolster its reputation
as the place where the world is
going to turn innovative ideas
into tomorrow’s breakthroughs."
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