ONTARIO SOCIETY OF PROFESSIONAL ENGINEERS

# The Potential of Artificial Intelligence

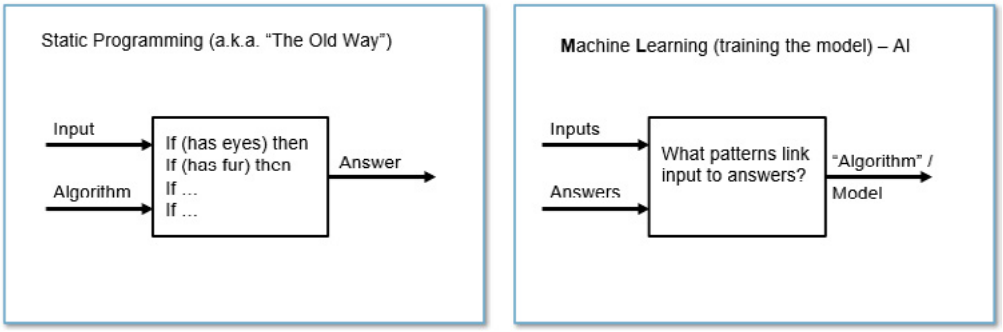
Peter Darveau, P. Eng. and Emanuel Corthay, P. Eng.

There is much hype about Artificial Intelligence (AI) in the media, often with grim predictions about job losses or the disappearance of people at the hand of super-intelligent machines. While risks exist, the potential benefits are immense with worldwide revenues expected to grow 16.4% in 2021 to $327.5 billion (IDC, 2021), with some putting the additional economic output of AI at around $13 trillion by 2030, boosting global GDP by about 1.2 percent a year (McKinsey, 2018). There is no single technology that currently has farther reaching implications than AI, which has applications in all fields including healthcare, law, farming, e-commerce, manufacturing, banking, and construction. It is already disrupting many industries and causing profound transformations by enabling machines to assist people in ways previously unimaginable. Used properly, AI can generate more sustainable growth, improve safety, and improve social equity. This, however, requires the careful application of safe and ethical AI principles by professionals trained in the strengths and weaknesses of this technology, and the availability of large amounts of good quality data.

## What is AI?

The basis of an AI system is to perceive the surrounding environment, obtain information, make predictions, and complete tasks with the help of various sensors. These systems can either make decisions or assist people in the decision-making process. Using AI is a paradigm shift, moving away from the traditional "programming" that requires each possible case to be hard coded, to a world where a large amount of historical data is provided, and the computer "learns" to model the right outcome based on past inputs and answers.

## Figure 1: The AI paradigm shift




## Opportunities for AI

Problems that are not easily described in a coded format, or those without a finite number of cases, are the most likely to benefit from AI. Problems that require understanding the natural world by recognizing elements of pictures (detecting obstacles in a car, cancer in x-ray images, or categorizing pictures of cats), speech (Google Assistant), or text are currently being handled by AI. But there are also many other use cases that are less known, such as the use of AI to sift

through large amounts of legal contracts to extract relevant information quickly, identifying defects in machines early by analyzing the subtle differences in the sounds they make while running and identifying patterns in stock trading to predict future performance.

## The Achilles Heel of AI: The Data

AI is only as good as the data that was used to train the system, both in terms of quality and quantity. Take, for example, an AI system used to sort through résumés in the HR department of a large company. If that company has always tended to favour a certain gender in its hire, then the system will perpetuate this bias as it will have "learned" or inherited that bias from the historical hiring data. The consequences of a bad AI system can have immense repercussions and thus requires careful considerations by trained professionals.

Considerations required for the implementation of an AI system include its design, the management of its training data, its deployment, and how it will be monitored and maintained throughout its entire lifecycle. Indeed, an AI system that works at one point in time or in one environment is not guaranteed to work in the future or with varied conditions. It needs to adapt to a changing environment and must be carefully changed, managed, and continuously tested to maintain safety, fairness, and integrity. This is quite different from previous, non-AI software systems that were paradoxically more robust due to simpler logic and more limited input. The logic of these systems is simpler to understand and often relies on people to apply the more subjective aspect of interpreting the results upstream, for example, by visually classifying images in healthcare. By contrast, explaining why an AI system is making a certain decision or reaching a certain confidence level is often difficult. Even worse, such systems can be vulnerable to carefully crafted inputs that bad actors can create to purposefully trick an AI system. For example, in a world where AI software is increasingly part of larger machines such as cars with autopilot assistants, it could become possible to push the car to turn off-road by applying a specific pattern on the road.

Another area of concern is using personal information in AI systems. Beyond the publicly documented abuse of using facial recognition to track people without their consent, there are many other scenarios where allowing the collection and use of data, for example, by government agencies, to improve public services, is beneficial. This has led to the creation of principles of ethical and safe AI by various government and regulatory bodies around the globe to address these concerns.

## Types of AI

Artificial intelligence can be divided into three categories: (1) operational intelligence, (2) perceptual intelligence, and (3) cognitive intelligence. Operational intelligence is the ability to compute rapidly and store memory. The natural advantage of a computer is its great computing and storage power. Enterprise Resource Planning (ERP) systems, software solutions that integrate all the processes needed to run a company, are examples of this. Perceptual intelligence is the use of vision, smell, taste, and hearing. It allows the system to interact with the environment by means of visual, auditory, and other stimuli to perceive the outside world and obtain information. A smartphone can perceive the environment via sensory devices such as cameras,

microphones, and corresponding software algorithms like Siri. Cognitive intelligence is the ability to understand, analyze, and judge. Humans understanding of language, judgement, individual's consciousness, and inferences of concepts are all expressions of cognitive intelligence. Presently, AI technology is in the transition from perceptual to cognitive intelligence.

### State of AI in Ontario

Canada is at the forefront of a new enthusiasm for AI, with leading academic research clusters at top Canadian institutions. In Ontario, those institutions are the University of Waterloo, McMaster University, and the University of Toronto. It is an extremely active area and fueled mostly by financial technology (fintech), automotive, and biotech start-ups.

In 2019, fintech alone accounted for $2.7 billion in investments (Invest Ontario, 2021). Massive investments in Deep Genomics, Waabi, and iHub at McMaster University are recent examples of funding in the biotech and autonomous vehicle sectors. The dynamism in these sectors explains Ontario's increasing influence in Big Data ethics around AI technology. Many more AI start-ups provide value chain, asset prognostics and health management, and risk management solutions to help businesses improve their operations, mostly by taking advantage of affordable high-performance computing that drives perceptual AI technology - reading, visualization (gaze, depth, recognition, detection), and speech (generation, recognition, translation).

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