AI and Big Data

Implications for
the Insurance
Industry in Canada

Emerging Issues
Research Report Series

Insurance Institute

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About the Insurance Institute

The Insurance Institute is the premier source of professional education and career development for the country's property and casualty insurance industry. Established in 1899, the Institute is a not-for-profit organization serving more than 40,000 members across Canada through 19 volunteer-driven provincial Institutes and chapters. For more information, please visit **insuranceinstitute.ca.**

About the CIP Society

Since 1998, the CIP Society has represented more than 18,000 graduates of the Insurance Institute's Fellowship (FCIP) and Chartered Insurance Professional (CIP) programs. As the professionals' division of the Insurance Institute of Canada, the Society's mission is to advance the education, experience, ethics and excellence of our members. The Society provides a number of programs that promote the CIP and FCIP designations, continuous professional development, professional ethics, mentoring, national leaderships awards, and understanding of emerging issues in the industry. The CIP Society, on behalf of its membership and for the benefit of the industry, is proud to have contributed to the development of this research report. Please visit **insuranceinstitute.ca/cipsociety.**

About the Institute's research

This research report represents the sixth in the Insurance Institute's Emerging Issues Research Series – providing relevant and insightful research reports on the issues impacting the property & casualty insurance industry in Canada. The report joins reports on cyber risks (2015), automated vehicles (2016), the sharing economy (2017), the changing workforce (2018), and climate risks (2020), as well as the demographics of the P&C insurance industry in Canada that the Institute has been conducting since 2007. For more information, please visit **insuranceinstitute.ca/research.**

About the author of this report

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Acknowledgements

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AI and Big Data: Implications for the Insurance Industry in Canada

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AI and Big Data Implications for the Insurance Industry in Canada

Executive summary

AI and big data tools are expected to reshape the insurance industry in Canada over the next 10 years. New approaches have the potential to enhance service for consumers, improve the efficiency of business operations, and allow insurers to help customers prevent losses.

Digital technologies are reshaping the world and will transform the way insurance products are designed, marketed, and distributed. One important element behind the changes underway is the remarkable explosion in the ability to collect, analyze, and automate learning from very large datasets. This report in the *Emerging Issues Research Series* focuses on two factors driving change: artificial intelligence (AI) and big data analytics. Change began several years ago and has accelerated recently. AI and big data tools are expected to reshape the insurance industry in Canada over the next 10 years. New approaches have the potential to enhance service for consumers, improve the efficiency of business operations, and allow insurers to help customers prevent losses.

Change also brings risk—and large change, like that associated with AI and big data analytics, will bring large risk. Concern is expected to increase for consumers, regulators, and others about explainability, fairness, availability, and privacy. Greater capacity to target products and pricing will benefit many, but it will also disrupt long-standing industry expectations for some. The industry should anticipate and prepare for broad public interest in how these emerging

tools for brokers and claims professionals working to support insurance customers. Over time, the industry will be judged by how it manages the opportunities and pitfalls. In particular, how will the insurance industry address the needs of vulnerable consumers that may be harmed by change? Industry actions will be judged relative to others in the insurance industry and to practices in other industries experiencing change. The industry will need to tailor its approach to ensure that solutions are provided to address the needs of insurance consumers, not just to reduce industry expenses.

Insurance companies are on a spectrum today in terms of the application of AI and big data analytics. Some companies are on a path toward widespread application of AI and machine learning, where the performance of models is measured, monitored, and adjusted frequently. They are building teams of data scientists and other experts. An early focus for some involves the application of advanced analytics to assess the pros and cons of real-time, dynamic pricing in the Canadian insurance market. In contrast, others in the industry are beginning the journey by speaking with vendors, implementing pilot modelling projects, and exploring options.

Change is inevitable. Digital interaction has become a norm in daily life and will be increasingly extended throughout the insurance industry.

tools will be used to best serve the interests of all of society. The industry must establish the capacity to explain changes to individual consumers and verify fair treatment for stakeholders.

Change is inevitable. Digital interaction has become a norm in daily life and will be increasingly extended throughout the insurance industry. Machine learning, explainable AI, and big data analytics hold great promise. The initial impact should be evident in improved efficiencies and better

As the insurance industry adapts to the digital age there is scope to shift the practices and reputation of insurance to better support the risk management needs of society. The industry is criticized by some as too focused on detecting and repairing losses. Change will be good for the insurance industry if AI and big data analytics are used to support an industry focus on risk management support for drivers, homeowners, and businesses, stressing the industry's capacity to predict and help consumers prevent loss.

It will also benefit brokers, adjusters, and other insurance professionals who are provided with better tools to understand the needs of consumers so they can spend more time using their experience and judgment to provide advice that will enhance the customer experience and less time completing paperwork. Importantly, change will benefit consumers who are offered personalized coverage and better claims resolution. This is the exciting potential if AI and big data analytics are introduced in the Canadian insurance industry with sufficient diligence, prudence, and care.

Foreword

The Insurance Institute is proud to publish this sixth instalment in a series of reports on emerging issues impacting the property and casualty insurance industry in Canada. These reports address important issues confronting the industry—cyber risks, automated vehicles, the sharing economy, the changing workforce, climate risks, and AI and big data.

The intention of this report is to provide research of value to stakeholders. This research report, and the series of reports in general, offers information and insights to enable insurance organizations to broaden their understanding of how emerging risks will impact the delivery of insurance products and services in Canada over the next five to ten years.

This report provides a broad perspective on what is known about machine learning, AI, and big data analytics and the potential issues that will impact the insurance industry in Canada in the near and distant future. This report focuses on both the remarkable opportunities to transform the industry through learning from enormous databases and the significant challenges expected as the industry commits to ensure that the resulting changes will benefit drivers, homeowners, and business consumers.

We hope that this research report is not only interesting and insightful, but also sets out the foundation for continued leadership by the insurance industry as society works to address the challenges resulting from the transition to a digital economy.

Sincerely,

PETER HOHMAN, FCIP, MBA, ICD.D
PRESIDENT & CEO,
INSURANCE INSTITUTE OF CANADA

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Introduction

"Any sufficiently advanced technology is indistinguishable from magic."

—ARTHUR C. CLARKE

Insurance is changing. Explainable AI and big data analytics are driving forces that will increasingly be applied across the insurance industry. There is excitement about the potential to better serve the risk management needs of consumers. The industry will have greater capacity to identify and manage risk at a granular level. This will be evident in coverage increasingly tailored to the specific needs of individual consumers, reduced prices for those with low risk, a better claims response for those experiencing a loss, and the capacity to prevent losses. Work in the industry will become more satisfying as the

and explain why the new systems result in changes in the treatment of consumers. Regulators will closely monitor the impact of introducing AI and big data analytics into the insurance industry. The new systems will be assessed by prudential regulators in terms of the risk to solvency, governance oversight, and reputational risk. The banking industry is developing a capacity for third-party verification that decision support algorithms are statistically fair. This issue will likely become increasingly important for the insurance industry. Market conduct regulators have been pressing the insurance

AI and big data analytics will accelerate innovation in Canada's insurance industry, an industry typically viewed as stable and unchanging.

automation of tedious tasks allows brokers, agents, adjusters, and others to focus on more rewarding activities that serve consumers. Change is inevitable as insurers adopt a digital mindset, and it will be positive for most.

The expectation of significant change will be accompanied by significant risk. If the new tools demonstrate that some members of a risk pool should pay less, then others will be asked to pay more, or they may find that coverage is no longer available. Many early AI algorithms and big data tools provide outcomes that cannot be explained to others in the industry, regulators, and, most importantly, to consumers. The industry should expect that some changes will be challenged as unfair, introducing regulatory and reputational risk. The industry will need to explain the implications of the changes to each consumer. Significant effort will be required throughout the industry to understand

industry to demonstrate fair treatment of consumers in underwriting practices and claims management, a conversation that will increase with emerging AI and big data tools. It is the responsibility of regulators to understand and, when required, challenge change in insurance practices to ensure fair treatment of consumers.

AI and big data analytics will accelerate innovation in Canada's insurance industry, an industry typically viewed as stable and unchanging. The pace of innovation will depend on the industry's ability to explain the changes to consumers, regulators, and other stakeholders. The process of digitization is proving to be more complicated for some than expected. Nevertheless, change is inevitable, even if the timing is uncertain. Significant benefits for consumers are possible if the introduction of AI and big data analytics is managed responsibly.

Six critical
questions

Six critical questions

What is big data analytics, and how will it support sound business decisions?

"Never interrupt someone doing what you said couldn't be done."

—AMELIA EARHART

The digital revolution is the shift from mechanical and analogue systems to a society reliant almost exclusively on digital systems. This transition began in the 1960s and accelerated with the growing popularity of the Internet, personal computers, and smartphones. Mass production of integrated circuit chips was accompanied by the capacity to produce chips with higher transistor density and lower manufacturing costs. Indeed, since 1970, it has been possible to double the number of transistors on an integrated

around the world are the direct result of the growing application of digital tools. For many years, insurance companies conducted rigorous actuarial analysis of recent loss experience to anticipate future claims. This was conducted quarterly or annually using established databases and analytical tools. Some other industries, however, began to assemble and assess extremely large databases that could not be assessed using commonly available tools. This included leading technology companies,

Remarkable and persistent improvement in the capacity to store and process extremely large datasets ultimately has benefited all of society.

circuit every two years, an extraordinary rate of growth sustained over 50 years.[1] The shift to a digital world marked the beginning of the Information Age. Data, information, and ultimately knowledge emerged as critical business assets.

In a digital economy it became easier to access large volumes of data, improve communications, and reconfigure production processes. The digital revolution set the stage for the automation of industrial and manufacturing processes, robotics, the Internet of Things, self-driving vehicles, cloud computing, big data analytics, and artificial intelligence. These changes are transforming society, a process that is described by some as the Fourth Industrial Revolution.[2] Rising productivity and living standards

banks, health care providers, meteorologists, and some government agencies. Use of cloud storage and computing, supercomputers, and new software facilitated approaches to the analysis of large datasets—big data analytics. In contrast, machine learning and AI do not necessarily require large databases.

Remarkable and persistent improvement in the capacity to store and process extremely large datasets ultimately has benefited all of society. These tools are now widely available, affordable, and usable across most industries. Leading insurers now employ teams of data scientists to assess datasets that were unimaginable 10 years ago, and it is expected that these tools will be in use across the insurance industry over the next 10 years.

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1   This is known as Moore's Law, named after Gordon Moore, who made this observation in 1965.
2   The term was introduced at the 2016 World Economic Forum in Davos, Switzerland, by WEF founder and chief executive Klaus Schwab.

Big data is the present and the future foundation for business and society.

Understanding big data

The term "big data" began to be used in the 1990s to describe the immense, often complex stores of data that were too large to be processed using software tools commonly available at the time. In particular, early data warehouses were used to store and manage large structured datasets generated by the companies, and software was developed to process the data. These tools were initially introduced in a few industries, such as banking, health care, and the public sector. The important change with the transition to big data involved collecting data from beyond the enterprise. Also, new data warehouses and software tools were extended to address both structured and unstructured data.

Since the 1980s, it has been estimated that the global capacity to store data doubled every 40 months.[3] The total data stored in the world has increased tenfold over the last seven years and is expected to increase a further tenfold over the next seven years.[4] This is a remarkable increase of 100-fold over 14 years. The explosion in the ability to store data was accompanied by a similar increase in capability to access and analyze this information, known as big data analytics or data science.

The big data revolution is in full swing. The cloud has joined data warehouses to make storage and accessibility even more efficient. The sources of new data are seemingly endless, as people put more of their lives and transactions online, creating digital ecosystems with third parties who can provide access to the new data. Big data is the present and the future foundation for business and society.

Characteristics of big data

The three "Vs" of big data set out in 2001 are volume, velocity and variety:[5]

- **Volume** relates to the size of the datasets. Billions or even trillions of records are flowing from social media, smart devices, videos, business transactions, industrial equipment, and other streams.

- **Velocity** refers to the rate at which new information is being generated and the speed necessary for it to be processed for timely insights. Increasingly this takes place in real time.

- **Variety** indicates the diversity of information sources that make up big data. This includes alphanumeric data provided by customers, audio and video files, emails, financial transaction data, and text documents.

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3   Hilbert and Lopez, "The World's Technological Capacity to Store, Communicate, and Compute Information."
4   Ibid.
5   Laney, "3D Data Management."

Four additional concepts that have emerged involve variability, veracity, visualization and value:[6]

- **Variability** cautions that differences in perception can give a different meaning to the same dataset, an issue that can only be solved through an understanding of context.

- **Veracity**, reliability, accuracy, and quality of the information used in big data analytics is essential to support sound decisions. Quality information supports sound decisions.

- **Visualization** of data through charts and other media makes information more accessible and understandable for stakeholders.

- **Value** provides a measure of the financial return from investing in data management and analysis.

The evolving characteristics are an indication of the changes in complexity of big data over the last 20 years. Moreover, the issue of veracity is critical for the insurance industry. Insurance is founded on trust. Management of these issues will affect the reputation of the industry. Insurers require quality data to make sound decisions, conduct risk assessments, and develop models. For example, data may be subject to adjudication when used to resolve claims, so it is important to document where data were acquired and to track its veracity.

Types of data

Data come from many sources. It is essential that business decisions are based on reliable data. The insurance industry, for example, is using traditional and non-traditional sources of acquired data about consumers. Initially, consumers provided information directly. Traditional sources for insurance include demographic, medical, exposure (such as type of car, value of contents, type and features of dwellings), behavioural, loss, and hazard information. New and non-traditional sources include the Internet of Things (IoT), online media (web searches, online buying, and social media), and personal preference data (such as cell phone operating system and email addresses).[7]

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6   IT Chronicles, "What Is Big Data?"
7   IAIS, "Issues Paper on the Use of Big Data Analytics in Insurance."

Type of data	Examples	Personal / non-personal	Use	Data source
Panel A: Traditional data				
Demographic data	Age, gender, civil and family status, profession, address	Personal	Risk Selection	Policyholders
Medical data	Medical history, medical condition, condition of family members, genetic testing	Personal	Risk selection	Policyholders
Exposure data	Type of car, value of building contents, type of features of dwellings	Personal / non-personal	Risk selection	Policyholders
Behavioral data	Smoking, drinking behavior, distance driven in a year, deductible choice, life insurance lapse rates	Personal / non-personal	Risk selection, marketing	Policyholders, industry statistics
Loss data	Claim reports from car accidents, liability cases	Personal / non-personal	Claims management	Policyholders, information exchange within industry
Population data	Mortality rates, morbidity rates, car accidents	Anonymised and aggregated personal data	Risk selection	Government, industry statistics, academia
Hazard data	Frequency and severity of natural hazards	Non-personal	Risk selection	Government, industry statistics, academia
Other traditional data	Credit reference, claim adjustment reports, information from the auto repair shops	Personal / non-personal	Risk selection, marketing, claims management	Policyholders, credit agents, partner adjusters or agencies involved in the claim
Panel B: New and 'non-traditional' data				
IoT data	Driving behavior (telematics), physical activity and medical condition (wearables), surveillance (smart home)	Personal	Risk selection, claims management	Data collection devices
Online media data	Web searches, online buying behavior, social media activities	Personal	Risk selection, marketing	Technology companies (Internet providers, search engine providers, e-commerce providers, social media platforms)
Personal preference data	Mobile phone operating system, email addresses	Personal	Risk selection, marketing, product development	Technology companies, Policyholders

Source: Geneva Association, "Big Data and Insurance: Implications for Innovation, Competition and Privacy," page 36.

There are a number of sources of data:

Acquired data

- "The automatic collection of data from sensors and readers in a factory, laboratory, medical, or scientific environment."

- "The gathering of source data for data entry into the computer."[8]

- Acquired data can include both traditional and new, non-traditional data.

Imputed data

- "The substitution of estimated values for missing or inconsistent data items (fields). The substituted values are intended to create a data record that does not fail edits."[9]

Insurers can purchase data about crime, vehicles, and dwellings. Customers can upload a photo of a damaged vehicle. Telematics can provide information about driving practices. Connected devices can provide real-time information about water damage or unauthorized entry. A remarkable array of new data are available.

Insurers have established processes to verify the accuracy of data provided directly by consumers. This includes assessing driving records with the police or a check of the property using a search of real estate records. Policyholders are aware of the information

perhaps with some feedback from insurers summarizing findings. Consumers typically are asked to approve acquisition of data from third parties, but the details are often unclear and there may be no recourse to consumers for verification. Special issues may arise when data are derived from other sources, like credit scores or the aggregation of telematics data by third parties.

Acquired data used to identify and approach potential consumers is an approach used by all industries, including insurance. Businesses are aware that most leads are incomplete, out of date, or otherwise unlikely to result

Special issues may arise when data are derived from other sources, like credit scores or the aggregation of telematics data by third parties.

provided and have an opportunity to ensure that the information is complete and correct. There is an expectation of utmost good faith in the accuracy of the information provided by customers and disclosure of the coverage provided by insurers. The core foundation of insurance is trust.

Challenges may arise in the verification of acquired consumer information that does not come directly from policyholders. Consumers can choose to directly share data from telematics and other devices,

in securing new customers. Nevertheless, this approach remains important to market goods and services to potential new customers. Supporting data are sufficient to provide some value, and occasionally they are very helpful. Businesses that rely on approaching potential consumers are increasingly investing time and effort in determining the value of the data available to support this effort.

Acquired consumer data are also used by the insurance industry to support resolution of claims and underwriting decisions.

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8   Both definitions are found at https://www.yourdictionary.com/data-acquisition.
9   Definition found at https://stats.oecd.org/glossary/detail.asp?ID=3406.

Insurers are responsible for ensuring that these data are accurate, even if it was not acquired directly, given that it is used to support appropriate decisions. For example, analysis of policyholder postings to social media may suggest that a claim should be denied, and industry best practices to ensure fair treatment of consumers are increasingly documented. Regulation and court rulings will provide direction about acceptable practices.

actual facts, but imputed data always has a random factor. Consumer and regulator expectations about the use of imputed data in the insurance industry is unclear and will evolve over time. Insurance is built on trust, so it is critical that the insurance industry understands how trust can be affected by changes in the data used to support decisions. Techniques used to impute data will likely be subject to a broader assessment of the fair

Insurance is built on trust, so it is critical that the insurance industry understands how trust can be affected by changes in the data used to support decisions.

Consumer and regulator expectations of the insurance industry when using acquired data for claims resolution and underwriting is much higher than data used for marketing. As social media tracking becomes increasingly automated, the responsibility to collect and verify the data used will increase.

Even with many sources to draw on, the data are often incomplete, and businesses will apply analytical tools to fill gaps whenever possible. It may be necessary to fill in gaps by estimating values based on similar cases or providing an estimate that is consistent with the person's existing data. The aim is to predict as closely as possible to the

treatment of consumers. As insurers advance in their digital journey, the line between marketing and underwriting will blend. If the approaches used cannot be explained to regulators, and perhaps directly to consumers, then insurers should question the value of using imputed data.

Sources of data

Swiss Re reports that insurance is a low touch industry. A study in the United States found that customers interact with their insurer, on average, only 2.7 times each year. Insurers investing in big data analytics are likely to acquire information from many sources:

Owned touchpoints: The insurer invests and controls these consumer touchpoints. They include agents, websites, and apps. The goal is long-term relationship building; the benefits are cost efficiency and control.

Paid touchpoints: The insurer pays for the digital touchpoint to reach the consumer, such as through paid searches and sponsorship. Paid touchpoints can include various channels, such as bancassurance and agents.
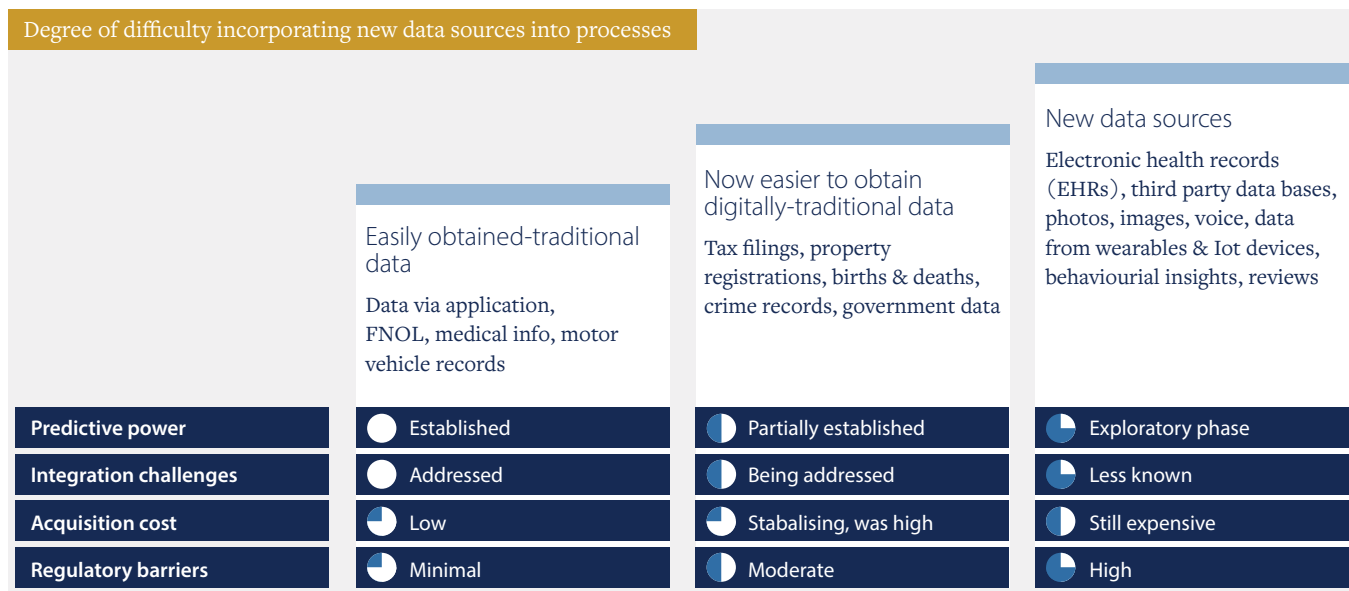
Earned touchpoints: Here the consumer becomes the touchpoint. This is when satisfied consumers become social media influencers and spread awareness.

Social touchpoints: An insurer interacts with third-party channels but uses its own profile, such as on Facebook or Twitter. Social media is forecast to be the fastest-growing digital advertising channel over the next five years.

Changing sources of data introduces issues about ownership. Insurers must determine if and how information collected from social media, for example, can be used to resolve a disputed claim. Who owns images of a property surveyed by a drone—the homeowner or the insurer? Consumers, regulators, and other stakeholders will be interested in the sources of data used by insurance companies, as well as how this information will be used, verified, and protected. Policyholders will be divided in their views about the use of some data sources, and insurers will need to win consumer confidence supporting the practices they adopt.

up and running at all times. The cost of using cloud storage is low and can be controlled, because the facilities often charge only for the space used. Cloud hosts may also provide processing and analytics. Each company must establish a balance between on-site storage and the use of the cloud. This includes consideration of the need to protect confidential information provided by consumers.

Big data, because of its vastness and complexity, requires the right tools to process and analyze it. Natural language processing helps to draw value from unstructured text, like emails, chat logs, and other textual data.

Degree of difficulty incorporating new data sources into processes

	Easily obtained-traditional data Data via application, FNOL, medical info, motor vehicle records	**Now easier to obtain digitally-traditional data** Tax filings, property registrations, births & deaths, crime records, government data	**New data sources** Electronic health records (EHRs), third party data bases, photos, images, voice, data from wearables & Iot devices, behaviourial insights, reviews
Predictive power	Established	Partially established	Exploratory phase
Integration challenges	Addressed	Being addressed	Less known
Acquisition cost	Low	Stabalising, was high	Still expensive
Regulatory barriers	Minimal	Moderate	High

Source: Swiss Re Institute, *sigma* No 5/2020, page 17.

Data storage

Big data only became possible as data storage capacity expanded in relation to its physical size. A business would purchase a few servers on-site, along with staff to run them, and make them accessible to the appropriate staff. Cloud storage, by contrast, stores data on a large number of servers connected digitally but not necessarily all in one place. Cloud storage is provided by a hosting company that services a number of businesses. The host is responsible for maintaining the storage facilities and for ensuring that it is

Chatbots on an insurer's website can ease the agent's workload by eliciting information from consumers for use in formulating policies or settling claims, leaving brokers, agents, and adjusters free to focus on tasks that are best served by human empathy and understanding.

The big data needs of the insurance industry require a variety of approaches to managing large data banks appropriate for the needs of its consumers. Finding the right fit is essential to optimizing a company's use of data. The skills and investments here cannot

The big data needs of the insurance industry require a variety of approaches to managing large data banks appropriate for the needs of its consumers.

be understated. Typically, this is not an incremental build, but requires a new set of people and practices.

Analytics and data science

Analysis traditionally focused on understanding what happened in the past. Analytics seeks to understand why something happened to anticipate what will happen in the future. Actuarial science, for example, uses analytics to predict the risk of loss in the future using predictive models and other tools. Data science is an emerging profession largely focused on working with big data analytics.

Internal and acquired datasets are, by nature, unstructured. The data must be put into a manageable form to ensure quality and be given a coherent structure to support analysis. When the data are ready, they can be

deeper to identify correlations and causal links between pieces of data quickly and efficiently. Analytics provides the business with a view of where it can improve, what trends to be aware of, how to better serve their customers, and what decisions they might make to stay ahead of the competition.

Data science is a term that has recently become popular, but it does not yet have a consistent definition. Advanced statistical analysis, or management science, was initially applied by the military with logistics optimization. Some describe data science as an applied field of statistics, typically with a focus on the analysis of big datasets. Others argue that data science is a new, interdisciplinary field using concepts from mathematics, statistics, and computer science. The objective of data science professionals is to extract insights from large sets of structured and unstructured data. Data

Analytics provides the business with a view of where it can improve, what trends to be aware of, how to better serve their customers, and what decisions they might make to stay ahead of the competition.

analyzed for insights that can help a business understand its consumers, visualize its direction, look for trends, and make decisions for its future.

Data processing organizes information into usable, visual formats, like lists, charts, graphs, and other formats useful to support analysis and decisions. Data analytics digs

science includes analytic approaches like data mining and machine learning.

Expert input is required to prevent spurious and suspect correlation. The OECD observes that "only through expert analysis can causation be well established."[10] Building a model is easy—understanding how the model can support better decisions is where expertise is required.

The Organisation for Economic Co-operation and Development (OECD) identifies four types of data analytics:[11]

1. Descriptive analytics: Analysis of what happened using past data

2. Diagnostic analytics: Assessing data to hypothesize why something happened

3. Predictive analytics: What is likely to happen in the near future

4. Prescriptive analytics: Suggesting a course of action going forward

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10   OECD, "The Impact of Big Data and Artificial Intelligence (AI) in the Insurance Sector."
11   Ibid.

Lessons for the insurance industry

Some industries have been using big data analytics for many years. Big data analytics and data science are the future of global interactions and transactions. With constant improvement in the algorithms, the growing dependence on smart technology, and the ever-increasing number of companies providing big data analytics services, these tools will become entrenched in every aspect of life for business, government, and individuals.

Analytic approaches used in the Canadian insurance industry will naturally expand to embrace the new tools offered by big data analytics. Some insurers in Canada have already gone all in on big data analytics. Analytics will grow and improve, along with the tools to drive its use, including data science. Big data analytics will support better decisions about claims, pricing, and operations—the foundation for sustaining healthy earnings.

Early commitment to big data analytics varies considerably across the Canadian insurance industry. Some companies, large and small, are recognized leaders within Canada and on the world stage. Others are just beginning the journey and have yet to establish a clear plan. These emerging tools will be important across the industry, so they must be assessed by insurance companies, brokers, agents, and adjusters. Remarkable change evident in other industries appears inevitable for the insurance industry, but the pace of change is uncertain. Each organization will need to determine the specific elements that are appropriate for their needs. The insurance industry will be transformed by this transition over the next 10 years.

Six critical questions

What is artificial intelligence and how will it support sound business decisions?

"Beware of false knowledge; it is more dangerous than ignorance."

— GEORGE BERNARD SHAW

Artificial Intelligence (AI) is being applied in organizations across the financial sector. It involves the use of computer algorithms to simulate and augment human intelligence. Modern statistical methods are applied to analyze datasets in an effort to find the optimal solutions to specific questions. The objective of AI is, ultimately, that it will be able to "think for itself," imitating human reasoning. Narrow AI is used to solve specific issues. General AI works to resolve multiple problems at the same time. That goal is in the future. At present, AI is being used to train machines to support decision makers through the assessment of large volumes of data and look for patterns through the study of human decision making.

These systems seek to reduce the risks associated with human error in the entry and analysis of critical consumer information. The banking industry and some insurance companies are developing decision support models to increase cross-selling of products

systems provide benefits that include faster execution of trades to secure the best prices, more frequent checks to ensure the portfolio complies with established investment guidance, and reduced risk of errors due to psychological or emotional causes.

With some exceptions, the insurance industry has been late to adopt machine learning and AI. Nevertheless, new systems are expected to be developed over the next 10 years across the insurance industry to support companies, brokers, and adjusters. Some insurance companies in Canada, large and small, have been vocal about actions underway that demonstrate their commitment to a digital future. The Centre for Study of Insurance Operations is a leader in describing how the insurance industry and independent brokers can best use AI to better serve customers.[13]

There is an expectation that chatbots and other new tools will be developed to better support communications with consumers when a claim is filed or a customer is

With some exceptions, the insurance industry has been late to adopt machine learning and AI.

to existing customers. This can include the development of digital campaigns and virtual marketing teams that support the efforts of relationship managers to target new offerings and promptly anticipate customer needs.[12] Fraud detection is a further benefit, as systems are trained to identify suspicious behaviour across very large datasets, supporting early and aggressive corrective action. This will be used in the real-time identification of organized criminal activity, money laundering, credit card theft, and other financial fraud. Investment managers are using algorithmic trading programs. These

exploring coverage alternatives. Most early development appears to address consumer-facing activities. The number and capacity of chatbots and other AI-based tools will increase. AI is also expected to improve internal industry operating systems, including workflow optimization and stronger support for communication between brokers and insurance and reinsurance companies, and between adjusters and companies. Moreover, AI tools and models will be developed by data scientists to improve insurance underwriting and develop coverage for previously uninsurable risks.

12   Microsoft, "Empowering the Digital Insurer."
13   Smola, "How Artificial Intelligence Is Transforming the P&C Insurance Industry."
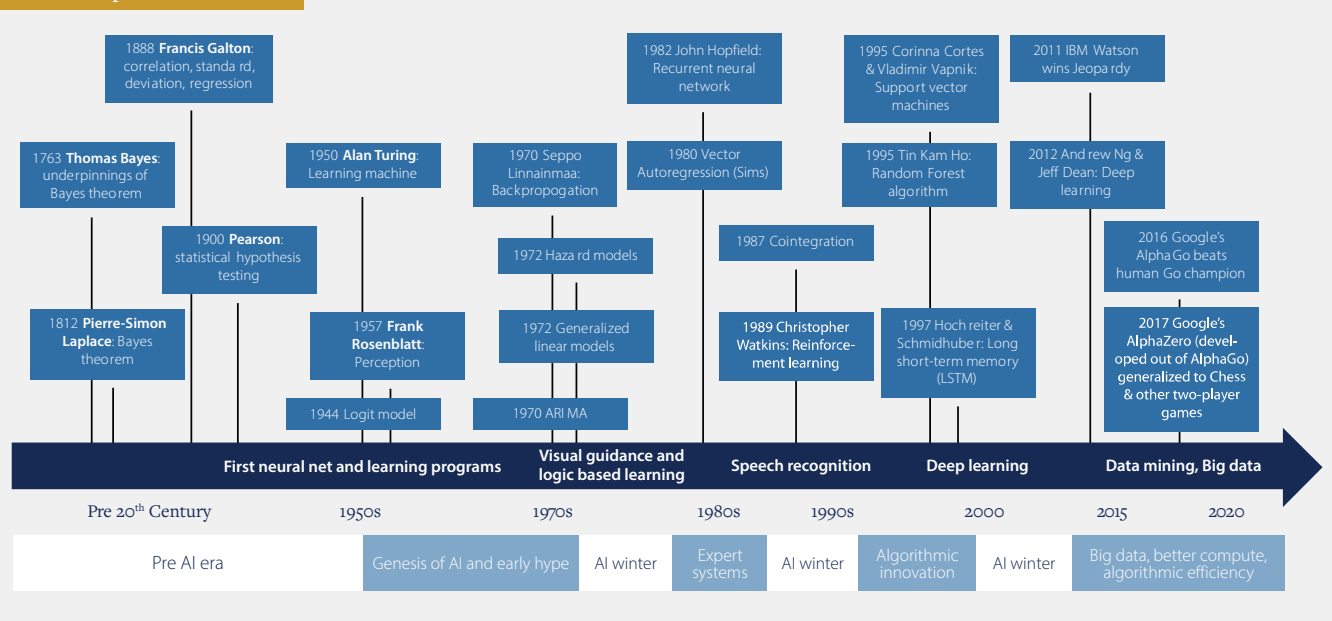
Importantly, AI looks to harness datasets to develop tools that will better anticipate and serve the needs of consumers. These tools also have the potential to automate many tedious tasks, freeing workers to focus on the more productive and satisfying efforts of serving consumers on a personal level. Responsible application of these new technologies holds great promise to reduce business costs, make work more satisfying, and better serve customers across most industries in Canada.
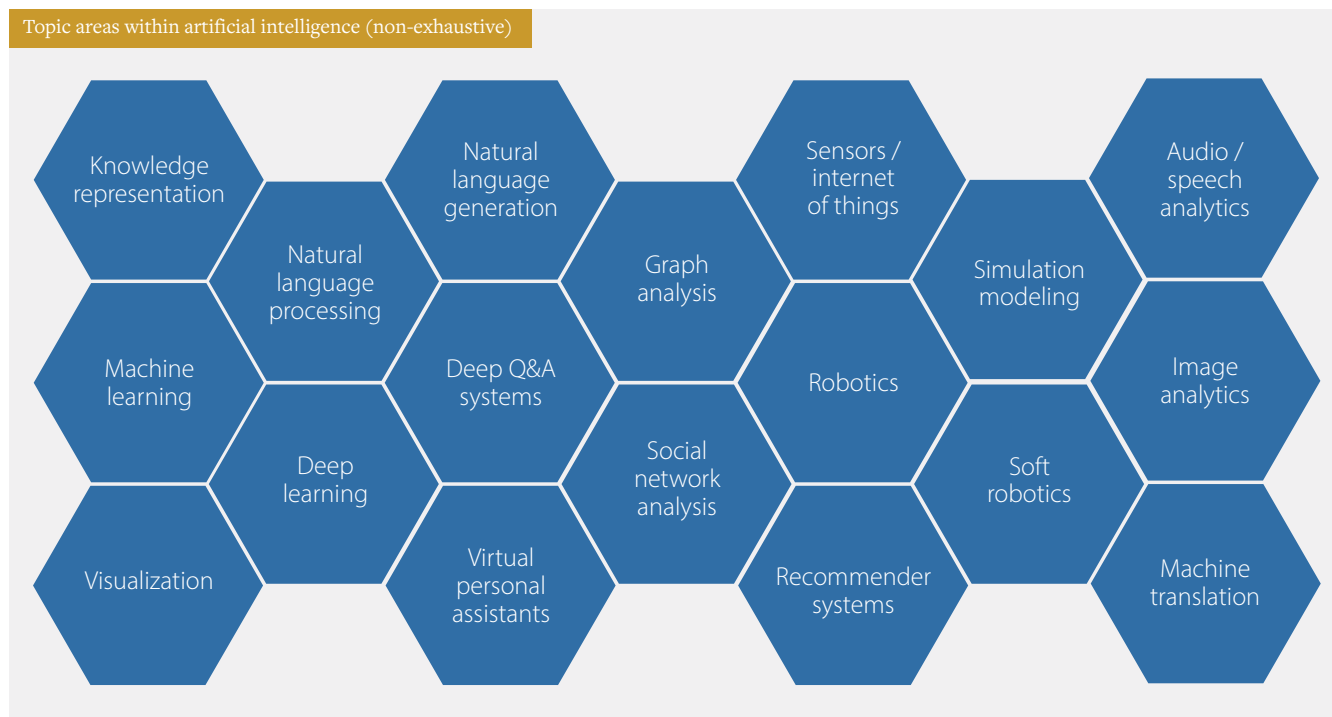
Understanding artificial intelligence

Artificial intelligence involves training machines to make decisions and support those who make decisions, in contrast to natural intelligence, where decisions are made by humans or animals. The objective of AI is to supplement or emulate human deduction, reasoning, and problem solving. Development of machines that can "think" has been an academic pursuit since the 1950s, but major breakthroughs required the co-development of large databases and analytical capacity.

Modern AI tools use computer algorithms to analyze and learn from datasets. These systems, developed by software engineers, adjust and adapt their learning as new data come in. The algorithms do not need the data to be structured. The systems are capable of acting on what they have learned to solve problems, reach conclusions, predict behaviour, operate machinery, and make recommendations. As new data are added to the existing dataset, the algorithms work to refine and improve their capacity to replicate or perhaps exceed the capacity of human decision makers. Examples of how AI works in everyday life are seen in our interactions with Siri, Alexa, and Google. Automated vehicles depend on AI to observe and adjust in real time to changing road conditions. Presently, AI is very good within specific areas. The aim for the future is to continue to increase its ability to handle more complex situations with greater accuracy and learn to behave in a more human-like way. Complex issues can be addressed by more complex architecture if there are data. A further challenge involves moving from narrow AI (addressing a single issue) to general AI (addressing many issues).

MI development timelines

1888 **Francis Galton**: correlation, standard, deviation, regression	
1763 **Thomas Bayes**: underpinnings of Bayes theorem	1950 **Alan Turing**: Learning machine
	1970 Seppo Linnainmaa: Backpropogation
1900 **Pearson**: statistical hypothesis testing	1972 Hazard models
1812 **Pierre-Simon Laplace**: Bayes theorem	1957 **Frank Rosenblatt**: Perception
	1944 Logit model

1982 John Hopfield: Recurrent neural network
1980 Vector Autoregression (Sims)
1987 Cointegration
1989 Christopher Watkins: Reinforcement learning
1972 Generalized linear models
1970 ARIMA

1995 Corinna Cortes & Vladimir Vapnik: Support vector machines
1995 Tin Kam Ho: Random Forest algorithm
1997 Hochreiter & Schmidhuber: Long short-term memory (LSTM)

2011 IBM Watson wins Jeopardy
2012 Andrew Ng & Jeff Dean: Deep learning
2016 Google's AlphaGo beats human Go champion
2017 Google's AlphaZero (developed out of AlphaGo) generalized to Chess & other two-player games

First neural net and learning programs | **Visual guidance and logic based learning** | **Speech recognition** | **Deep learning** | **Data mining, Big data**

| Pre 20th Century | 1950s | 1970s | 1980s | 1990s | 2000 | 2015 | 2020 |

| Pre AI era | Genesis of AI and early hype | AI winter | Expert systems | AI winter | Algorithmic innovation | AI winter | Big data, better compute, algorithmic efficiency |

Source: Swiss Re Institute, *sigma* No 5/2020, page 5.

Topic areas within artificial intelligence (non-exhaustive)

Knowledge representation	Natural language generation	Sensors / internet of things	Audio / speech analytics		
Natural language processing	Graph analysis	Simulation modeling			
Machine learning	Deep Q&A systems	Robotics	Image analytics		
Deep learning	Social network analysis	Soft robotics			
Visualization	Virtual personal assistants	Recommender systems	Machine translation		

Source: PwC, "AI in Insurance: Hype or reality?," page 4.

The pioneers who developed deep learning are Yoshua Bengio at the University of Montreal, Geoffrey Hinton at the University of Toronto, and Yann LeCun at New York University. In 2018 they were awarded the Turing Award and $1 million for the conceptual and engineering breakthroughs. Jeff Dean of Google AI said, "Deep neural networks are responsible for some of the greatest advances in modern computer science, helping make substantial progress on long-standing problems in computer vision, speech recognition, and natural language understanding. At the heart of this progress are fundamental techniques developed starting more than 30 years ago by this year's Turing Award winners, Yoshua Bengio, Geoffrey Hinton, and Yann LeCun. By dramatically improving the ability of computers to make sense of the world, deep neural networks are changing not just the field of computing, but nearly every field of science and human endeavor."[14]

AI is currently used to compete at the highest levels in strategic games, conduct complex military simulations, and operate automated vehicles. Indeed, leading artificial intelligence systems have defeated the highest-rated competitors in games that include chess, go, and Jeopardy. Chatbots or virtual assistants have developed an extraordinary capacity to understand human speech and participate in a conversation, answering questions quickly and efficiently. These natural language and machine learning tools can be designed to provide customer service, marketing, and sales support. The apparent intelligence of these tools comes from access to large datasets containing more information than can be retained by human decision makers. Some people prefer interacting with these systems relative to their experience with some human representatives.

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14   ACM, "Fathers of the Deep Learning Revolution Receive ACM A.M. Turing Award."

Machine learning and deep learning

Machine learning is a subset of AI. One element, supervised learning, focuses on performing a particular task and searches for patterns that allow the machine to improve its performance when measured against a database of human decisions. Unsupervised learning models are not told what to look for. Deep learning also supports speech recognition used in chatbots and other applications.

Deep learning, an evolution of machine learning, delves into vast stores of data, performing a task over and over again, "thinking" its way through and constantly improving the output measured against a dataset of human decisions. Deep learning is

If the sample of human decisions is biased, the algorithms will repeat these errors. Teaching artificial intelligence systems to support decision making will always be constrained by the quality of data and the design of the initiative.

AI will be applied across society

Machine learning and AI tools are being developed for use across society. Tools are in place, for example, so consumers can make an appointment or book a reservation by speaking to a machine. Natural language tools support conversations with customers seeking an appointment with their dentist or a reservation at a local restaurant. The COVID-19 global pandemic accelerated testing that was already underway,

> Deep learning, an evolution of machine learning, delves into vast stores of data, performing a task over and over again, "thinking" its way through and constantly improving the output measured against a dataset of human decisions.

essential in speech and language recognition, translation, facial recognition, automated vehicle cameras, chatbots, and online shopping. Deep learning is responsible for the product and video recommendations that pop up on computers and mobile screens. The more deep learning algorithms are used, the better they perform.
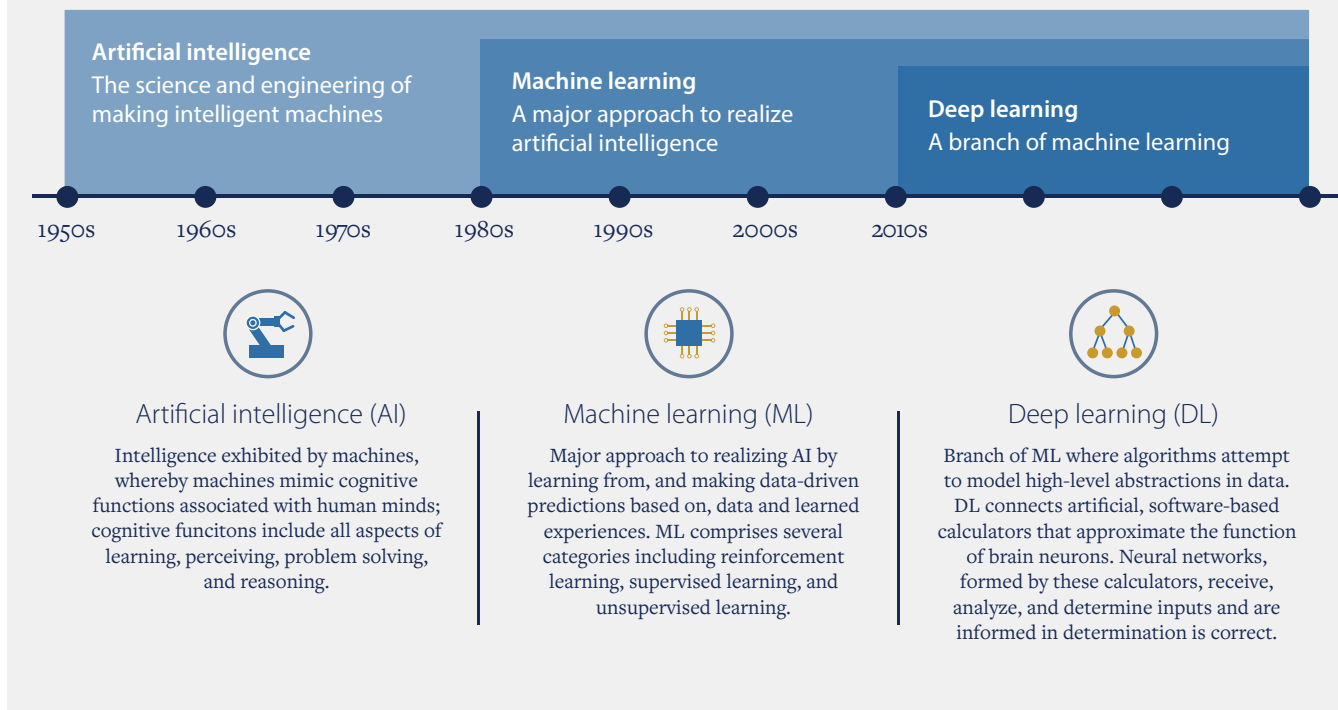
Both machine learning and deep learning are essential to the field of artificial intelligence. Although neither type of learning is capable of the human thought processes that AI aims to duplicate, their ability to dig into the data has made possible the advances seen in recent years.

Concerns sometimes arise about AI systems that inadvertently learn to make biased decisions that are unfair to certain customers. These algorithms learn to make decisions or provide advice from the examples of previous human decisions provided by the data.

resulting in early implementation of systems by a broad range of users. AI pioneers, like Amazon, found that these tools provided a competitive advantage through a period of great uncertainty for consumers. Systems are available for businesses in a broad range of circumstances, with increasing simplicity to implement, declining cost to acquire, and growing acceptance by consumers. Breakthroughs in online payment capacity and security accompanied the increasing availability of AI tools, further speeding up consumer acceptance of new systems.

The military has developed sophisticated training tools that simulate an enemy attack. Meteorologists have significantly improved the accuracy, narrowed the geographic focus, and extended the duration of weather forecasts using these tools. Amazon and Google train their systems to learn about individual customers and anticipate their future needs.

Artificial intelligence can deliver industry expectations through machine learning and deep learning.

Artificial intelligence
The science and engineering of making intelligent machines

Machine learning
A major approach to realize artificial intelligence

Deep learning
A branch of machine learning

1950s   1960s   1970s   1980s   1990s   2000s   2010s

Artificial intelligence (AI)

Intelligence exhibited by machines, whereby machines mimic cognitive functions associated with human minds; cognitive funcitons include all aspects of learning, perceiving, problem solving, and reasoning.

Machine learning (ML)

Major approach to realizing AI by learning from, and making data-driven predictions based on, data and learned experiences. ML comprises several categories including reinforcement learning, supervised learning, and unsupervised learning.

Deep learning (DL)

Branch of ML where algorithms attempt to model high-level abstractions in data. DL connects artificial, software-based calculators that approximate the function of brain neurons. Neural networks, formed by these calculators, receive, analyze, and determine inputs and are informed in determination is correct.

Source: McKinsey & Company, "Insurance 2030–The impact of AI on the future of insurance," based on "The history of artificial intelligence," blog entry by Rockwell Anyoha, sitn.hms.harvard.edu.

The OECD observed that "when AI or machine learning is being applied for business purposes, such as online retail and recommender systems, the outcome would be to show products, social media posts and search results, which would require accuracy of data, but may not lead to considerations of an ethical nature or on its criticality.

When an AI decision has a large stake, such as a financial decision…the decision making process of the algorithm becomes important and the fact that it is a black box causes concerns." [15]

There should be transparency and responsible disclosure around AI systems to ensure that people understand AI-based outcomes and can challenge them.

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15   OECD, "The Impact of Big Data and Artificial Intelligence (AI) in the Insurance Sector."

Leading voice assistants, including Amazon's Alexa (named for the ancient library in Alexandria), Apple's Siri (meaning 'beautiful woman who leads you to victory' in Norse) and Google Assistant, are female by default.

A recent United Nations study has highlighted that female-voice AI reinforces harmful gender biases and has made recommendations to limit the practice of making digital assistants female by default and most importantly, "to develop the advanced technical skills of women and girls so they can steer the creation of frontier technologies alongside men."[16]

The OECD identified five principles for the responsible stewardship of trustworthy AI:

1. AI should benefit people and the planet by driving inclusive growth, sustainable development, and well-being.

2. AI systems should be designed in a way that respects the rule of law, human rights, democratic values, and diversity, and they should include appropriate safeguards—for example, enabling human intervention where necessary—to ensure a fair and just society.

3. There should be transparency and responsible disclosure around AI systems to ensure that people understand AI-based outcomes and can challenge them.

4. AI systems must function in a robust, secure, and safe way throughout their life cycles, and potential risks should be continually assessed and managed.

5. Organizations and individuals developing, deploying, and operating AI systems should be held accountable for their proper functioning in line with the above principles.[17]

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16   UNESCO, "I'd blush if I could: closing gender divides in digital skills through education."
17   OECD, "The Impact of Big Data and Artificial Intelligence (AI) in the Insurance Sector."

AI is not expected to replace human workers in the insurance industry, as has been evident in industries that include agriculture and manufacturing. Tedious, unsatisfying tasks may increasingly be completed with support from these tools, allowing existing workers to focus on better serving the needs of customers.

A widely cited 2018 paper by Joy Buolamwini, a researcher at the MIT Media Lab, and Timnit Gebru, a member at Microsoft Research, found that the error rates for three commonly used commercial facial recognition systems (Microsoft, IBM, Face++) were much higher when identifying darker-skinned individuals than when identifying white-skinned individuals, and that darker-skinned females are the most misclassified group. The disparity appears to be in part because the data sets used to train the systems are predominantly male and white. The research paper supports earlier findings that algorithms trained with biased data result in algorithmic discrimination and pushes for algorithmic transparency and accountability.[18]

Debate about the ethics of AI often focuses on concerns about the threat of mass unemployment and the danger to humanity if machines that will never be able to achieve emotional intelligence and empathy should develop cognitive intelligence that grows to exceed humans. These issues have been subject to extensive academic study and become part of popular culture through movies and writing. Recent concerns about the application of these algorithms focus on the fair treatment of consumers in terms of explainability, unintended bias, and impact on diversity.

Augmentation versus automation

Over the next 10 years, artificial intelligence and machine learning are expected to support existing workers to become more productive, effective, and satisfied with their work. AI is not expected to replace human workers in the insurance industry, as has been evident in industries that include agriculture and manufacturing. Tedious, unsatisfying tasks may increasingly be completed with support from these tools, allowing existing workers to focus on better serving the needs of customers. Nevertheless, the promise of the new systems will likely be accompanied by concern about job security. The potential for significant positive change will result in uncertainty for risk-averse employees inclined to be skeptical about change. This may be more evident in industries like insurance where most employees are not familiar with the rapid change evident in many other industries. A key will be the potential for rapid change. AI may reshape the workplace by replacing some jobs with others that require different skillsets.

Warren Buffet expressed concern at an annual meeting of Berkshire Hathaway about the importance of business leaders being prepared to address questions about the "plight of displaced workers":

"If you cut everybody's hours in half, it's one thing. If you fire half the people and the other half keep working [then] we need to have policies that take care of the people that become the roadkill in the process."[19] Business leaders planning to use artificial intelligence and other emerging tools must develop expectations about the anticipated changes across their business plans and communicate this information with employees, consumers, and other stakeholders.

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18   Buolamwini and Gebru, "Gender Shades: Intersectional Accuracy Disparities in Commercial Gender Classification."
19   Carrier Management, "What Warren Buffett Said about AI."

Data scientists and others developing the new artificial intelligence tools need to be directed to explain their new findings—a task that may be difficult when assessing large datasets.

Appropriately trained employees will increasingly be supported by AI tools over the next 10 years.

Through the implementation stages anticipated over the next 10 years it is expected that existing employees will need to be trained to implement the findings from the new learning systems across most industries. This would include the insurance industry, where initial tools are likely to focus primarily on supporting existing employees.

The major impact of robotics and other technologies that brought job losses in manufacturing and agriculture due to automation were the result of decades of change. Appropriately trained employees will increasingly be supported by AI tools over the next 10 years.

Lessons for the insurance industry

Big data analytics is a natural next step for the insurance industry, but the application of machine learning and artificial intelligence represents a greater change to conventional practices. Some insurers in Canada are leading the way through the establishment of world-class research labs and by fostering a culture of innovation. Others will follow as the new systems are proven to improve efficiency and make it possible to better serve customers and reduce costs. Some change is driven by innovative companies that sometimes operate at arm's length from the industry. Some strive to disrupt current practices through the application of new approaches and techniques. Successful innovators will likely be drawn into mainstream industry practices over time. Many insurance companies have

established formal processes to identify and directly support new approaches to finance, data, and ideas.

Deployment also presents challenges for the insurance industry. Once a model is developed and tested there will be challenges to integrate it into existing systems and processes. This will require close collaboration between analytics and information technology teams.

A challenge in the application of machine learning and artificial intelligence in insurance involves explainability. Systems that learn to better anticipate outcomes of interest to the insurance industry must also be capable of explaining how they arrived at those conclusions. Explainability is important if the insurance industry is to confidently apply the new approaches. Consumers, regulators, and other stakeholders will demand an explanation why the new tools generate different outcomes. Data scientists and others developing the new artificial intelligence tools need to be directed to explain their new findings—a task that may be difficult when assessing large datasets.

Moreover, training will be important for the industry. AI is unlikely to change the number of people working in the Canadian insurance industry over the next 10 years, but it is expected to change the skills required in many circumstances. The success of organizations, like the Insurance Institute of Canada, to provide training will be important in supporting the success of the industry in the transition to a digital future.

Six critical questions

Why are AI and big data analytics expected to transform the insurance industry?

"Clinging to the past is the problem. Embracing change is the answer."

— GLORIA STEINEM

There may be no limit to the extent artificial intelligence and big data analytics can transform the insurance industry. The potential to deliver custom coverage tailored to individual customer needs matched with accurate pricing is fast approaching. Responsible application of emerging data science tools holds great promise to better serve the risk management needs of customers. Insurers will be able to confidently offer coverage for risks that were not previously insurable, sometimes in collaboration with government agencies and other partners. Change and improvement will be evident throughout the insurance

doing its part to flatten the curve and was able to showcase its adaptability in a changing environment. This included remote claims resolution and innovative approaches to welcome new customers, demonstrating that the path forward to a digital future for the insurance industry may come sooner than widely anticipated.

Insurance analytics

Analytics has been applied to insurance for many years. An initial focus involved rigorous actuarial assessment of recent industry loss data. Pooling of industry data

It is an exciting time for those who embrace a culture of change and innovation—terms not typically associated with the insurance industry in Canada.

industry, including insurance and reinsurance carriers, brokers and agents, adjusters and appraisers, and others across the industry. It is an exciting time for those who embrace a culture of change and innovation—terms not typically associated with the insurance industry in Canada.

The digital transition began many years ago, accelerated over the last five years, and is expected to speed up over the next 10 years. Initially, change was led and driven by a small number of industry innovators in Canada and elsewhere around the world. Increasingly, insurance consumers have begun to press the industry to adopt approaches proven to be successful in other industries. For example, many in the insurance industry identify digital-first retailers like Amazon as pioneers in the development of customer-friendly experiences they would like to bring to Canadian insurance consumers.[20]

The COVID-19 pandemic forced the industry to accelerate the introduction of some changes. The insurance industry was

was essential for effective risk assessment and development of actuarially sound pricing for consumers. Development of industry datasets was promoted by the industry and insurance regulators. Some jurisdictions required insurance companies to regularly file detailed analyses of industry loss data to justify decisions about auto insurance rates. Actuarial analysis and data analytics were central to insurance practices and embraced by regulators as being in the public interest.

Over time, companies developed tools to assess pooled industry data blended with additional information provided by their consumers. Change was most evident with larger companies that had access to extensive information about their consumers and applied it to the development of a more granular assessment, which is important for risk selection, rating, and strategy. Privacy regulations largely accepted and endorsed evolving industry practices, focusing on the assurance that customer information would be protected and only used for insurance purposes.

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20   Malik, "COVID-19 Has Accelerated Changes to the Claims Industry."

Eventually, the industry sought information that was not provided directly by consumers. Beyond auto coverage, this involved developing models to assess low-probability, high-consequence tail events, like potential to devices in the home or place of business. Some companies have begun to access social media information. The objective is to learn more about consumers. When this information is used properly it can provide

Telematics and connected devices are a visible demonstration to consumers of the emerging capacity in a digital age to directly link behaviour and use with insurance practices.

claims from a catastrophic earthquake.[21] This included acquiring information purchased from third-party vendors and using independent models. Insurers can also learn from broader data that may focus, for example, on the neighbourhood or community rather than the individual.

Some insurers assess data from telematic devices installed in vehicles and connected devices in homes or on industrial equipment. Real time information is provided directly to insurance companies. The information is used to link insurance coverage and pricing with consumer behaviour. Drivers, homeowners, and businesses can also use the information to monitor and improve their behaviour and sometimes prevent losses. "Today, they can price on the basis of real usage and driving behavior, such as how fast a vehicle is being driven and whether it is being driven at night."[22] Telematics and connected devices are a visible demonstration to consumers of the emerging capacity in a digital age to directly link behaviour and use with insurance practices. This includes devices within vehicles, mobile apps on the telephone of consumers, and direct connection through the Internet of Things

a stronger foundation to resolve claims and develop products that better anticipate consumer needs and expectations.

This evolution of analytics was accompanied by a remarkable increase in the capacity to store, assess, and quickly access enormous datasets. These emerging tools are well suited to improve a broad range of insurance practices. Much more data is readily available and accessible to support interactions throughout the insurance process, develop new coverage, and improve assessment of consumer risk. Increased capacity has been accompanied by a significant reduction in the cost of the new systems and a growing pool of talented analysts.

Insurance companies seek more information about current and potential consumers. Tools to assess and understand the data are evolving rapidly, including digital ecosystems that provide easy access through the cloud to third-party providers. Capacity to manage and process growing volumes of quality information have increased remarkably over the past 25 years. Also, the analytical tools to assess and understand the data continue to grow in capability.
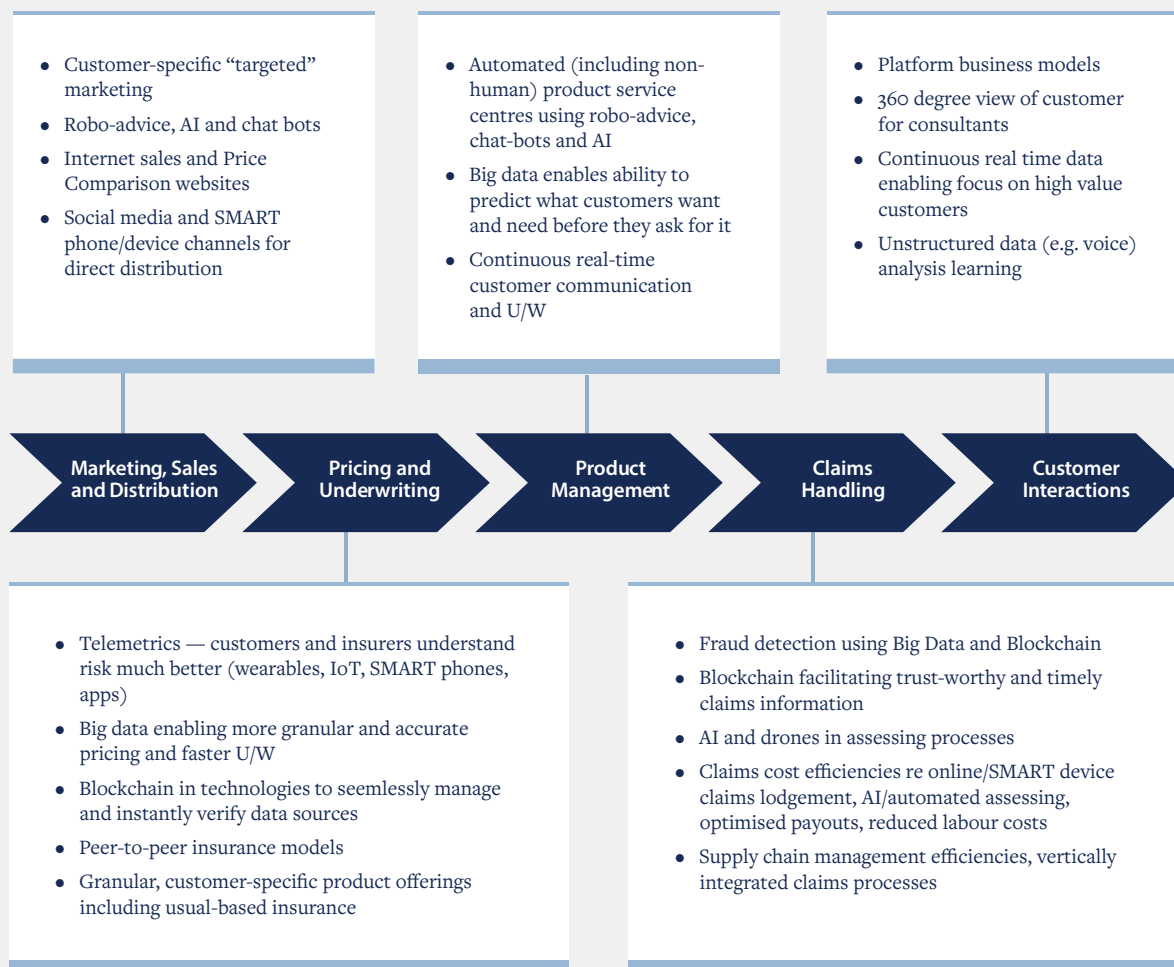
EY found that "While it is still early, insurers are exploring how to deploy AI and ML technology…some are beginning to invest substantially, while others are more cautious. What problems does the industry think it needs AI to solve?"[23]

21   Kunreuther and Grossi, eds., Catastrophe Modeling.
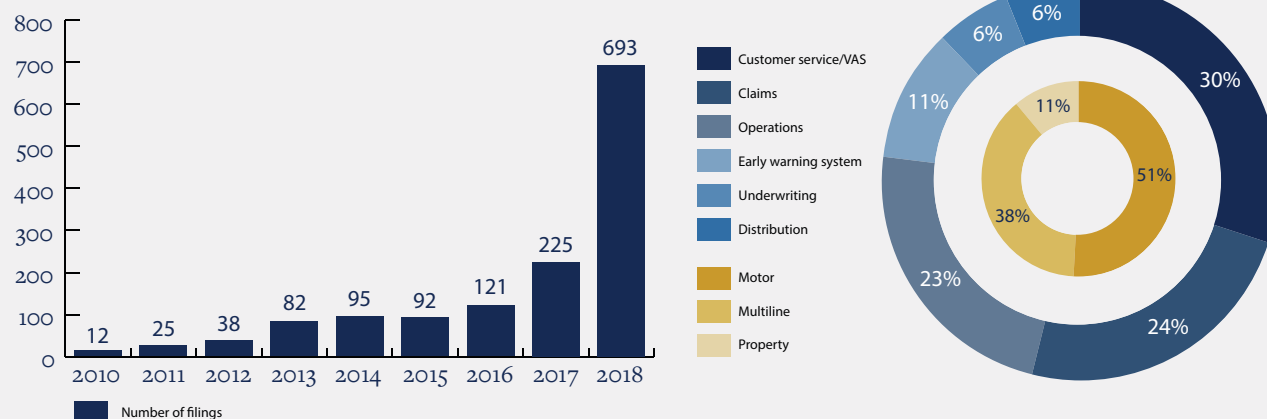22   Balasubramanian, Libarikian, and McElhaney, "Insurance 2030."
23   Tapestry Networks, "Three Ways AI Will Transform the Insurance Industry."

Digitalization and the insurance value chain

- Customer-specific "targeted" marketing
- Robo-advice, AI and chat bots
- Internet sales and Price Comparison websites
- Social media and SMART phone/device channels for direct distribution

- Automated (including non-human) product service centres using robo-advice, chat-bots and AI
- Big data enables ability to predict what customers want and need before they ask for it
- Continuous real-time customer communication and U/W

- Platform business models
- 360 degree view of customer for consultants
- Continuous real time data enabling focus on high value customers
- Unstructured data (e.g. voice) analysis learning

Marketing, Sales and Distribution → **Pricing and Underwriting** → **Product Management** → **Claims Handling** → **Customer Interactions**

- Telemetrics — customers and insurers understand risk much better (wearables, IoT, SMART phones, apps)
- Big data enabling more granular and accurate pricing and faster U/W
- Blockchain in technologies to seemlessly manage and instantly verify data sources
- Peer-to-peer insurance models
- Granular, customer-specific product offerings including usual-based insurance

- Fraud detection using Big Data and Blockchain
- Blockchain facilitating trust-worthy and timely claims information
- AI and drones in assessing processes
- Claims cost efficiencies re online/SMART device claims lodgement, AI/automated assessing, optimised payouts, reduced labour costs
- Supply chain management efficiencies, vertically integrated claims processes

Source: IAIS, "Issues Paper on Increasing Digitalisation in Insurance and Its Potential Impact on Consumer Outcomes," page 8.

Growth bar graph and composition of patents (donut chart, 2018) at insurers

Legend (bar / donut):
- Customer service/VAS
- Claims
- Operations
- Early warning system
- Underwriting
- Distribution
- Motor
- Multiline
- Property

Bar graph values — Number of filings:
2010: 12, 2011: 25, 2012: 38, 2013: 82, 2014: 95, 2015: 92, 2016: 121, 2017: 225, 2018: 693

Donut (outer): 30%, 24%, 23%, 11%, 6%, 6%
Donut (inner): 51%, 38%, 11%

Source: Swiss Re Institute, *sigma* No 5/2020, page 14.

Underwriting applications

Big data analytics and, to a lesser extent at this time, artificial intelligence are essential to support underwriting decisions. Analytical capacity and data quality have emerged as

Smaller organizations can learn from the findings of others or purchase tools and algorithms to use at their level.

Aggressive, long-term analytics initiatives involve large datasets. The presence of

Analytical capacity and data quality have emerged as critical factors to determine the performance of insurance companies.

critical factors to determine the performance of insurance companies.

Development of datasets and analytical tools were initially put in place to support industry actuaries. Over time, the insurers began using statisticians and data scientists to support underwriting decisions. Research by the Insurance Institute of Canada and others set out company and industry strategies to find, hire, train, and otherwise develop individuals trained to implement this work. The Institute's "Demographics" report concluded that "technology is redefining workforce needs," noting that "analytics and data analysis skills are growing in importance and urgency as organizations look to increase their ability to collect, interpret and monetize data and their competitive advantage."[24]

Some companies seek to secure as much high-quality data as possible about consumers. The data are organized and assessed to support risk selection, rating, and product design. The information can be analyzed to better assess risk for new and existing consumers. The gathered data can more accurately determine what each customer should pay to properly cover their risks. Potential new customers will be welcomed with an accurate estimate as their risk is proactively assessed.

Other companies, in contrast, seek only minimal information to support decisions and seek to avoid acquiring and managing additional data. Simply put, companies can choose to take as much or as little data as they are comfortable gathering and analyzing.

older, legacy information technology systems may serve as a constraint for companies that aspire to bolder data management and analysis efforts: "Many insurers have enormous amounts of valuable data in numerous systems, some of which are legacy systems. But they were often not recorded in an easily-interrogable form with consideration for future use. So many data are not readily accessible."[25] Companies involved in recent acquisitions may have multiple systems in place with distinct histories and processes. Telematics and connected devices generate large datasets. Companies focused on managing climate risks have access to enormous volumes of climate history data. Some consumers use social media and produce text and video information useful to insurers. Data management is a complex challenge for insurance companies, and it will grow in complexity over time.

The goal for insurers is to develop products aligned with consumers' evolving risk management needs with a price adequate to cover anticipated claims and expenses. Investment in analytics is a priority for innovative companies seeking to be early to offer new products and services and to support the modernization of legacy systems. This is evident for insurance companies, brokers, adjusters, and others across the insurance industry. Confident and successful leadership in the insurance industry requires an understanding of the needs of consumers, and increasingly analytics is critical to identify the best path forward.

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24   IIC, "Demographics of the P&C Insurance Industry in Canada 2017–2027."
25   Raman and Lam, "Artificial Intelligence Applications in Financial Services."

The COVID-19 pandemic accelerated the introduction of new tools, as conventional assessment of claims was difficult or impossible.

Claims resolution

The greatest opportunity for insurers with the new technology is to help consumers avoid claims. Warnings about an approaching hailstorm could help insurers get their consumers to move their vehicles to a safer location. Water sensors in a home may help insurers inform homeowners before a water damage claim develops. Telematics may be used to help drivers adopt safer driving practices.

Adjusters and claims managers are also beginning to use artificial intelligence tools and analytics to improve customer support and resolve claims. New approaches are in development to collect and process damage claims. PwC, for example, identifies early, intermediate, and advanced stages in the application of artificial intelligence to claims management:[26]

- Build predictive models and analyze claims process flows.

- Build deep learning tools that process images and estimate repair costs and build capacity to monitor input from remote sensors and prevent losses for consumers.

- Build models to anticipate the frequency and severity of claims through the insurance cycle and link this to product design, distribution, and marketing to better anticipate consumer needs.

Beyond the three priorities identified by PWC, many also stress the importance of models to reduce claims fraud.

The COVID-19 pandemic accelerated the introduction of new tools, as conventional assessment of claims was difficult or impossible. Intact, for example, reports that 10 to 20 percent of vehicle-collision damage estimates in 2019 were based on photographs and videos submitted by customers, and this increased to more than 60 percent during the pandemic. "Intact said photos are sent electronically for about 60% of auto claims, giving them the opportunity to create estimates and pre-order parts for repair. Adjustment to these estimates can later be made when cars are being repaired."[27]

New approaches to claims resolution were introduced sooner or their use was expanded. Importantly, consumers got to partake in the completion of their claim.

Claims innovation timeline			
Claims journey	Past	Present	Future
FNOL (First Notice of Loss)	Complex forms which require explanation	Customer uses the phone, post, online / mobile apps	Automatically: IoT satellite, weather stations, etc.
Claims admin	Manually by insurer staff	Data entry by insurer staff	Digitally augmented support in complex situations; AI advice
Data gathering / fraud detection	Rudimentary fraud analytics	Combination of manual and models to identify fraud	Automated using analytics like big data and AI
Claims estimate	Manual claims adjudication	Mix of manual inspection or advanced technologies	Automated claim adjudication
Settlement	Reimbursement via bank cheques / drafts	Direct to vendor (garage, hospital) and reimbursement	Instant payout, automated validation, options (eg, replacement, second hand)

Source: Swiss Re Institute, *sigma* No 1/2020, page 38.

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26   PwC, "AI in Insurance."
27   Malik, "COVID-19 Has Accelerated Changes to the Claims Industry."

Additionally, the wait time for them to receive payment may be reduced because they do not have to wait for an adjuster or appraiser to be available in person. Companies have established a new relationship with the

significantly reduce criminal activity. New tools are also emerging for companies to identify and confront individuals who make fraudulent or exaggerated claims. Company efforts can be strengthened through analysis

The application of analytics to detect fraud "is among the fastest areas of tech adoption in the insurance industry."

consumers they plan to build on, with an expectation that proven practices will not return to previous approaches.

The application of analytics to detect fraud "is among the fastest areas of tech adoption in the insurance industry."[28] EY observes that "AI technology is increasingly deployed to detect and prevent [insurance] fraud, which costs the industry an estimated $40 billion a year."[29] Machine learning and AI tools can assess company data and information pooled across companies to detect suspicious criminal practices. Most fraudsters follow patterns that AI systems can be trained to identify. The new information can be

of social media postings and third-party data. Rules, regulations, and case law setting out acceptable investigative practices continue to evolve as these approaches are increasingly adopted, which benefit greatly from the advancements made in AI. A priority for the industry is to reduce false positives and the resulting terrible claims experience for consumers wrongfully accused of fraud. AI can address this through its ability to learn and shift to address emerging fraud patterns rather than constantly finding signals of where fraud used to be found.

A number of companies are providing AI tools to support the claims management process

A priority for the industry is to reduce false positives and the resulting terrible claims experience for consumers wrongfully accused of fraud. AI can address this through its ability to learn and shift to address emerging fraud patterns rather than constantly finding signals of where fraud used to be found.

designed to better inform and support early and forceful response by the police. Company and industry investments in fraud-reduction tools are expected to increase over the next 10 years because they hold great promise to

of insurers. Canadian insurance publications regularly report on companies operating in Canada. More than a dozen US-based companies were identified in a 2019 article by Mike Thomas, including the following:[30]

28   Faggella, "Artificial Intelligence in Insurance."
29   Tapestry Networks, "Three Ways AI Will Transform the Insurance Industry."
30   Thomas, "25 AI Insurance Companies You Should Know." Slava Kurilyak provides another list
       in "Artificial Intelligence (AI) in Insurance."

Examples of companies supporting claims through AI	
AI INSURANCE	AI Insurance provides software tools for small insurance companies to automate aspects of claims management;
avaamo	Avaamo is an artificially intelligent chatbot that collects and compiles claims information from consumers;
Betterview	Betterview uses AI to estimate repair costs based on historic experience;
CCC INFORMATION SERVICES INC.	CCC Smart Estimate provides a prediction of vehicle repair costs;
CLAIM GENIUS	Claim Genius offers an AI platform to assess collision photos and videos and estimate damage;
Clearcover	Clearcover uses photos to estimate claims;
Galaxy.AI	Galaxy AI's Galacticar provides an app so customers can report claims;
H_2O.ai	H2O.AI provides insurance supports that include systems to detect suspicious claims;
Lemonade™	Lemonade has developed chatbots and AI algorithms to rapidly process claims;
nauto®	Nauto seeks to avoid collisions by providing loss avoidance advice to feed drivers in real time;
riskgenius	The RiskGenius platform streamlines insurance claims using custom algorithms;
SOLARIA labs A LIBERTY MUTUAL ENDEAVOR	Solaria Labs' Auto Damage Estimator uses AI to process vehicle damage photos; and
trōv	TROV has developed chatbots that support claims management.

Examples of value-added and preventive services		
Service type	Auto	Property
Preventive services	• Safe driving alerts • Maintenance rewards • Anti-theft and breakdown alerts • Geo-fencing (eg, alert if driven outside of safe neighbourhood)	• Remote monitoring and alerts • Flood monitoring in home basements • Automatic shutdowns of gadgets during fires
Value added services	• Assistance to buy car • Concierge services • Alert when vehicle is moved, towed or hit when parked	• Property security advice • Facility maintenance • Emergency repair services

Source: Swiss Re *sigma* No 1/2020, page 32.

Loss prevention will grow in importance in claims management. Connection with the Internet of Things, sensors, and other devices support development of value-added and preventative services for vehicles and homeowners. Swiss Re, for example, has identified the opportunities above.[31]

Investment management

Insurance companies are major investors. AI and analytics can be applied directly by insurers to support investment decisions or can be used by third parties to advise insurers. The skills and capacity of these tools are expected to improve considerably over the next 10 years. They can be applied to support actions to minimize investment risk, improve returns, and measure compliance with established strategy.

Some companies prioritize preservation of capital, choosing to minimize the risk of loss in the portfolio. This may involve investing exclusively or predominantly in high-quality bonds that are frequently held to maturity.

The new tools are unlikely to have a significant direct impact on companies that adopt the most conservative investment strategies. Nevertheless, insurers will need to understand how these tools are used by third-party advisors.

Some insurance companies are active in the management of their investments. This may include purchasing bonds with different risk and reward characteristics that may be traded before maturity, or investments in equities, real estate, or other assets. AI and analytics can be applied directly by insurers to support management of investment risk and be used by third parties to advise insurers.

Over the next 10 years, all insurance companies are expected to focus increasingly on environmental, social, and governance (ESG) issues in their investment management, including climate risk.[32] This will include conservative and active investors. Several Canadian insurance companies are international leaders in the development of tools to measure and manage climate risks.

AI and analytics can be applied directly by insurers to support management of investment risk and be used by third parties to advise insurers.

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31   Swiss Re, "Data-Driven Insurance?" page 32.
32   Kovacs, "Climate Risks."

The Task Force on Climate-Related Financial Disclosure established an insurance companies working group to develop disclosure guidance focused on underwriting and investment activities.[33]

Moreover, companies that support the United Nations Principles for Sustainable Insurance commit to "integrate ESG issues into investment decision-making and ownership practices."[34] Tools are emerging to assess and disclose ESG and climate risks in insurance investments.

Hiring and staff support

Machine learning and AI are becoming mainstream in human resources practices in all industries, including insurance. They are increasingly embedded in recruitment, onboarding, performance analysis, training, and retention. Automating some processes allows human resources professionals to focus their time on making better decisions to establish and maintain the best workforce.

It is now easier to inform existing employees about vacancies and, where appropriate, reach outside the company to other qualified people. Employee referrals can be tracked to recognize staff that are successful in helping to attract others and understand the kinds of employees identified. Candidate résumés collected online can be subjected to an initial screening by automated systems that

eliminate the tedious task of eliminating those who are not qualified. Aspects of background checks can also be automated AI tools can be used to support human resources professionals to further narrow the pool of candidates using information found in applications supplemented by additional information collected from references, online searches, or analysis of social media.

Expanded data about staff experience and interests can be used by human resources staff to develop more effective training programs, establish career pathways, and strengthen retention of critical employees. Analysis of previous work experience can better match existing staff with open roles. Technology can be used to better connect companies with current and prospective employees on a personal level.

Marketing

Marketing teams can leverage customer datasets using customer relations management technology and AI functions. Optimization models can support cross-marketing campaigns and the matching of niche insurance products to better serve the needs of consumers. Chatbots can provide an AI-empowered conversation interface. These approaches can be applied by insurers, brokers, agents, managing general agents (MGAs), adjusters, and others in the insurance industry.

AI tools can be used to support human resources professionals to further narrow the pool of candidates using information found in applications supplemented by additional information collected from references, online searches, or analysis of social media.

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33   UNEP FI, "UNEP FI Working with 16 Global Insurers to Better Understand Risk & Implement TCFD Recommendations."
34   UNEP FI, "PSI Principles for Sustainable Insurance."

Lessons for the insurance industry

Artificial intelligence and big data analytics can be applied across the insurance industry to improve performance. This journey of transition began several years ago and recently accelerated. The importance of AI and analytics will grow over the next 10 years. Current industry leaders plan to press

efficiency. Also, it is important to adapt to evolving circumstances. For example, the COVID-19 pandemic served to accelerate the digital journey for several companies.

Using the right people is essential, but the best are in high demand. Companies compete with other insurers, banks, pensions, asset managers, and regulators to find skilled

> A small number of companies account for most of the early insurance industry focus on AI. Swiss Re reports that 10 insurers account for more than 80 percent of the AI patents in the United States over the past 10 years, and five companies account for more than 85 percent of the patents in China.[35] These early adopters are striving for enterprise-scale transformative change.

forward and bring further change, but every company does not need to aspire to lead. It is essential that brokers, agents, adjusters, and companies establish a strategy committing to a path forward.

Insurers committing to innovation included strong leadership from the highest levels within the company that helped spread a culture of innovation and digital transformation. Innovation was established as a priority, and experimentation was encouraged. Discussion focused on overcoming barriers and lessons learned. Importantly, these efforts were consistently tied to establishing a better experience for consumers and increasing operational

analysts. It is critical that analysts have or can acquire a solid understanding of the factors that contribute to insurance risks and opportunities.

The remarkable experience of Amazon and several other global leaders demonstrates the enormous potential for change powered by a commitment to artificial intelligence and big data analytics. Learning algorithms designed by creative data scientists can improve the performance of the Canadian insurance industry. However, it is critical to allow sufficient time for new approaches to mature, and the journey must allow for some failures along the way.

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35   Anchen, Bohn and Sharan, "Machine Intelligence in Insurance."
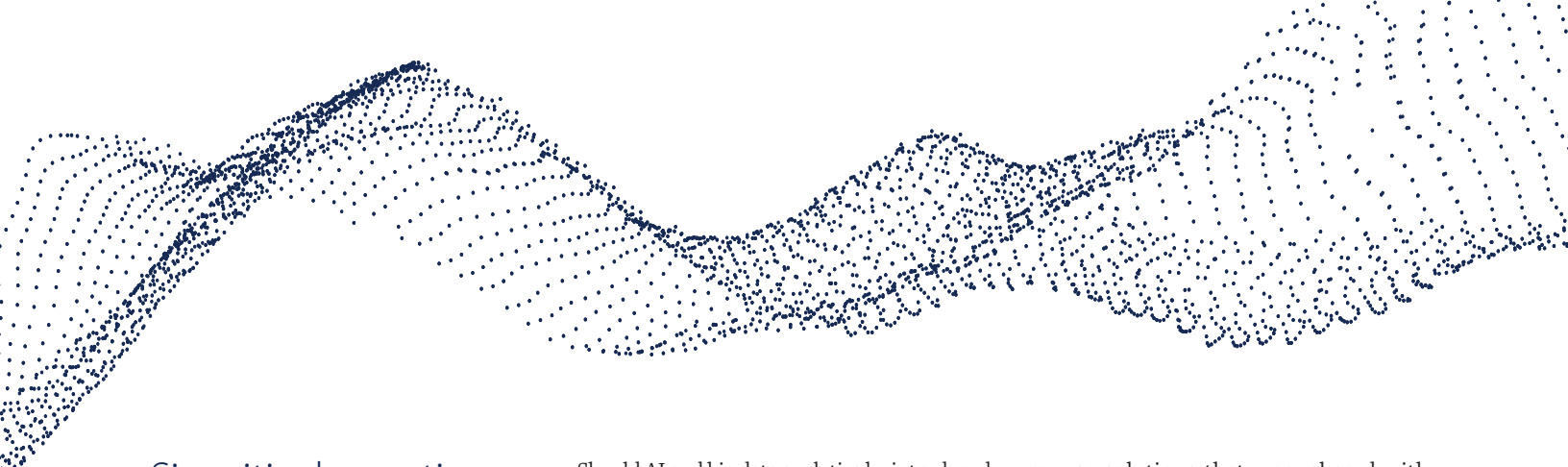
Six critical questions

How can the insurance industry best anticipate and manage emerging risks?

"Your scientists were so preoccupied with whether they could, they didn't stop to think if they should."

— JURASSIC PARK

Should AI and big data analytics be introduced in the insurance industry? It is critical for the industry to focus on insurance consumers and their perspective. Innovation leaders involved in the application of artificial intelligence and big data analytics consistently identify a number of challenges that extend across an array of industries. Four risks that are addressed here include explainability and transparency, fairness and bias, availability, and privacy and security. Solutions to facilitate the adoption and consumer acceptance of AI and big data analytics include lessons that can be learned from other industries and early adopters, but these must be tailored to the specific needs of Canadian insurance consumers.

propose solutions that were shared with interested stakeholders.[36] Regulatory bodies like the Office of the Superintendent of Financial Institutions or the Canadian Council of Insurance Regulators could impose requirements. The Property and Casualty Insurance Corporation, which was established more than 30 years ago to protect insurance consumers in the unlikely event that a company fails, could evolve to also assume responsibility to determine consumer acceptability of evolving insurance practices. Presently, it is unclear how the industry would seek to determine the social acceptance of new approaches.

The UK Centre for Data Ethics and Innovation warns about three potential detrimental outcomes that could arise from the implementation of AI for personal insurance:

- The collection and sharing of large data troves, which could impinge on privacy, if done without the express consent of customers.

- Hyper-personalized risk assessments, which could leave some individuals "uninsurable" by revealing previously unseen indicators of risk.

- New forms of nudging, where insurers use AI to alter the behaviour of consumers in a way that could be viewed as intrusive.[37]

While consumers, regulators, and a number of other stakeholders will ultimately provide judgment about the social acceptability of decisions made by the insurance industry, it is unclear what forum would be best to explore and test new ideas. The OECD has endorsed the approach of regulatory sandboxes, where new ideas are tested in a controlled setting with regulatory supervision. TD Bank established an expert panel to participate in a roundtable to identify critical issues and

Explainability and transparency

Explainability is the ability to explain how assessment of large datasets with complex models and algorithms arrived at a conclusion. Analysts may struggle to explain why a factor, or combination of factors, appears to have a significant impact on the assessment of risk. Consumers deserve to be informed about changes in their expected risk of loss, as reflected in the price they must pay for

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36   Contant, "Focus on These Three Areas When Developing AI Best Practices."
37   CDEI, "AI and Personal Insurance," page 4.

Black box models that predict outcomes without an explanation are incomplete and not ready for use.

coverage, and it is important that this can be resolved if insurers are to rely on the emerging tools. Explainability emerged as a significant challenge in other industries with

to make a flood insurance claim than those without a boat.

An assessment of causality may find that homes located in the flood plain are more

An expert panel advising TD Bank found three critical elements involved in addressing explainability:[38]

- Identifying what needs to be explained
- Expecting the unexpected
- Educating and reaching consensus

the introduction of AI and big data analytics, and insurers must learn from this experience.

The OECD stresses that analysis should be informed by insurance knowledge and be directed to assess the root causes of loss.[39] Predictive models reporting correlation of findings are not as effective in explaining the expected risk as are models focused on causality. For illustration, analysis may find that homeowners with a boat are more likely

likely to flood due to the location of the building and, coincidently, homeowners located near water are more likely to own a boat. The risk of flooding does not increase with the purchase of a boat—it is the result of location in a flood plain. While humans are able to distinguish this relationship, AI may not be able to. It is the industry's prerogative and ethical responsibility to properly manage how it uses the data that are collected and analyzed. Black box models that predict outcomes without an explanation are incomplete and not ready for use.

In 1992, the Supreme Court of Canada ruled that the use of age and gender as a rating criterion was discriminatory but was permitted because reliable data that would allow the insurance industry to set premiums based on non-discriminatory criteria were not available. Two dissenting judges argued that an insurer must not only prove a statistical correlation but a causal connection.[41] Young drivers, particularly young male drivers, experience more collisions, but is it socially acceptable to use age and gender as rating criteria? Age and gender contribute to the understanding of the risk of loss, but can the industry dig deeper to identify and assess the root causes of collision risk? Younger drivers in Canada are involved in more collisions because, in part, they do not yet have sufficient driving experience. Novice drivers of any age are perhaps at greater risk. The industry championed the development of graduated licensing as a public policy response to confront the experience of more collisions for newer drivers.[41]

38   TD, "Responsible AI in Financial Services," page 8.
39   OECD, "The Impact of Big Data and Artificial Intelligence (AI) in the Insurance Sector."
40   Gomery and John, "Gender Neutral."
41   Mayhew, Simpson, and Singhal, "Best Practices for Graduated Driver Licensing in Canada."

AI and big data analytics can support real-time monitoring of connected risks in vehicles and homes. This can be used to shift the focus of insurance from an actuarial analysis of historic correlations of loss with socioeconomic factors to a deeper assessment, monitoring, and measurement of underlying factors contributing to the risk of loss. Big data analytics conducted by skilled analysts with expert support will allow for deeper study of the root causes of risk. This will improve the capacity of the insurance industry to anticipate the risk of future losses,

delays in the time required to secure approval and uncertainty in the rates that will ultimately be approved; these are risks that would be expected to increase the values requested relative to a system that relies on competition to best serve consumers. Nevertheless, transparency is one element where insurance companies in Canada can learn from rate regulation.

Rate regulators are trying to help insurance consumers, and this often includes better communication about insurance practices. This is increasingly evident for climate-related

The debate about the use of credit scores by insurance companies provides a warning that effective communication is challenging.

which is good for consumers, particularly those with low risk. But acceptance of the new tools requires that the findings are understood by insurers and can be explained to consumers. Analysts must identify the path between the identified change and the resulting adjustment in the risk of loss, and this information must be shared with consumers. The debate about the use of credit scores by insurance companies provides a warning that effective communication is challenging.

Consumers typically do not understand how the insurance industry functions in Canada. Many speculate about behaviours that increase or reduce the cost of insurance, but actual industry practices are not evident nor made clear to consumers. This disconnect contributes to the view that insurance is a necessary expense rather than a critical form of protection for drivers, homeowners, and businesses.

Rate regulation harms insurance consumers. It is expensive for insurance companies to comply with rate regulatory processes, and this cost must be recovered from consumers. Rate regulation stifles innovation and delays introduction of new practices that would benefit consumers. Moreover, insurance company rating proposals must anticipate

risks. Alabama, Connecticut, Florida, Georgia, Louisiana, Maryland, Mississippi, New Jersey, New York, North Carolina, Oklahoma, Rhode Island, South Carolina, and Texas are some states where insurance companies provide premium discounts to homeowners that install certified loss reduction measures.[42] Residential consumers pay a higher price for insurance when these features are not present and are offered a discount when they are. Some regulators *require* that insurers offer a discount, and the value is determined by the company. Others have established a minimum discount.

Insurance companies in Canada typically charge a lower premium for consumers with lower risk, but the justification is often unclear. The promise of insurance discounts is one of the most important factors causing more homeowners in Texas to install hail-resilient roofs and thus reduce their risk of hail damage. Actions taken by rate regulators to improve the transparency of the insurance process provide insights into practices that can better inform insurance customers—practices that can be introduced in jurisdictions fortunate not to have rate regulation. This improves the relationship between consumers and brokers; building trust and enforcing safer practices have a financial benefit for both parties.

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42   Smart Home America, "List of Mitigation Insurance Discounts and Tax Savings."

It will be crucial for the industry not to act blindly on the findings provided by these new tools without a rigorous understanding of how consumers and the public as a whole interpret these actions.

Fairness and bias

The insurance industry is committed to the use of decision support tools that are fair and unbiased in the assessment of risk, determination of pricing, resolution of claims, and treatment of customers. Analysis of large datasets and the introduction of machine

odds with the approach adopted by the insurance industry. The Merriam-Webster online dictionary, for example, provides 28 definitions of "fair," but does not mention actuarial valuation of risk in any of them.

If insurers triple the price of hurricane insurance in Florida when new research finds

Statistical methods for assessing fairness involve evaluating disparities in error metrics for a variety of inputs. Machine learning fairness toolkits include AI Fairness 360, Fairlearn, and Google's ML-fairness-gym.

learning decision support tools hold great promise to reduce unconscious bias in industry practices. Nevertheless, it is critical that the industry be vigilant in the search for unanticipated bias in these complex new analytical tools.

Statistical methods for assessing fairness involve evaluating disparities in error metrics for a variety of inputs. Machine learning fairness toolkits include AI Fairness 360, Fairlearn, and Google's ML-fairness gym. These systems have been applied in other sectors to assess the fairness of systems in simple environments, but their capacity is difficult to judge in a broader context.

A tool developed to support hiring at Amazon was found to have learned to prefer male candidates over female ones, penalizing applications that included the word "woman" or those attending all-female colleges. The software was trained on data submitted mostly by men over a 10-year period. Despite efforts to fix the bias when it was detected, Amazon eventually abandoned the project because it lost faith in the impartiality of the system.[43] The initiative was doomed from the start because it was based on poor data about unbiased decision making.

The insurance industry strives to align prices with the expected risk of loss. Insurers have a view of fairness based on actuarial valuation of risk. Public views of fairness and acceptable practices are complex and sometimes at

a tripling of expected hurricane damage, this is actuarially fair, but is it fair for a senior on a fixed income who may no longer be able to afford the cost of staying in her home? Actuarial valuations are a dimension of determining fairness, but consumers seek assurances that the industry understands the broader context of modern life. Concepts like accident forgiveness are examples of the Canadian insurance industry adapting to address consumer expectations.

Systemic racism is a current issue in the world. Implementation of AI and big data analytics in the insurance industry may involve questions about the fair treatment of visible minorities. The insurance industry has had an ongoing struggle with its reputation in general, including explainability and visibility. It will be crucial for the industry not to act blindly on the findings provided by these new tools without a rigorous understanding of how consumers and the public as a whole interpret these actions. Analytic teams that are diversified to reflect the makeup of consumers are more likely to identify and correct biases.

The application of emerging tools will test the insurance industry's capacity to respond to the evolving needs of consumers. It will be critical to assess the expanding databases to ensure that the information is unbiased and will support equitable decisions.

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43   Hamilton, "Amazon Built an AI Tool to Hire People but Had to Shut It Down Because It Was Discriminating Against Women."

An expected outcome of the application of big data analytics is the prospect that insurance companies will begin introducing coverage of risks that were previously seen to be uninsurable.

Availability

Vigorous competition is found in most private insurance markets for vehicles, homes, and business across Canada. Nevertheless, company decisions to withdraw coverage can have a devastating impact on consumers. Large shocks, like Hurricane Andrew in Florida, significantly disrupted the availability of coverage as many companies sought to exit the market. Withdrawal of coverage may threaten the livelihood of consumers if they are unable to secure insurance needed so they can drive to work or maintain a loan for their home or operate their business. It is important that companies considering the prospect of withdrawing from a market or line of business have more information available than could be provided by the findings from a new model.

An expected outcome of the application of big data analytics is the prospect that insurance companies will begin introducing coverage of risks that were previously seen to be uninsurable. The availability of more information and stronger analytical tools will likely determine, over the next 10 years, that new coverage is viable. Consumers will find that they are able to transfer additional risks to the insurance industry for a reasonable premium. An early example involves the introduction of residential flood insurance.

Privacy and security

Federal and provincial agencies are actively working with the insurance industry to protect the privacy of consumer information. A focus has been on the protection of personal information collected from customers and potential customers. Information collected must only be used for the specific purposes identified to the applicant. The industry has prioritized many actions to safeguard customer information from cyber criminals, hackers, and unauthorized staff. Best claims management practices are emerging with respect to the ethical use of information from social media and other sources. Companies have established processes to resolve consumer complaints.

Federal and provincial privacy legislation applies across all industries. The insurance industry successfully argued for some accommodations to best serve the specific needs of insurance consumers, such as the treatment of consent. The industry will need to continue to adapt its practices to ensure that the specific elements of big data analytics and the development of machine learning algorithms comply with (and can be shown to comply with) evolving privacy regulations, especially as additional data resources are used by AI, such as social media.

A primary focus of cyber criminals and hackers over the past decade was on banking, health care providers, and government agencies. The insurance industry has adapted practices tested in other industries to address the needs of insurance companies.[44] Ransomware and other cyber threats that target smaller organizations warn of the need to build cyber awareness and protection across the insurance industry, including brokers, agents, and adjusters. Enhanced protection of consumer information from cyber criminals is needed by insurance companies and across the industry and will grow in importance with the development of shared access to large industry databases.

As previous studies by the Insurance Institute of Canada have shown, the insurance industry

The industry will need to continue to adapt its practices to ensure that the specific elements of big data analytics and the development of machine learning algorithms comply with (and can be shown to comply with) evolving privacy regulations, especially as additional data resources are used by AI, such as social media.

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44   Kovacs, "Cyber Risks Report 2019."

must do more to prepare for cyberattacks.[45] In the past, hackers and cyber criminals largely ignored the insurance industry. However, as more data are gathered, stored, and analyzed, there is greater motivation for cyber criminals to attack the insurance industry, and the consequences of those hacks will be more dangerous for insurers, brokers, and consumers.[46]

Lessons for the insurance industry

Machine learning, artificial intelligence, and big data analytics hold great promise and risk for insurance consumers and the insurance industry. Early innovators in insurance and other industries report four critical challenges that the insurance industry will need to address: explainability and transparency, fairness and bias, availability, and privacy and security. These issues are not new, but they are amplified with AI and big data analytics. Introduction of the evolving technology is expected to increase the importance of the industry demonstrating to consumers, regulators, and other stakeholders that insurers understand and are proactively working to address these important concerns.

Emerging tools have the potential to improve relations with insurance consumers if introduced responsibly. While most consumers are expected to experience better outcomes, some consumers will likely experience higher prices, reduced availability, and other unwelcome changes. Companies unable or unwilling to prepare for these challenges will find that consumers are ready to move their business elsewhere, which might not be as simple as it was in the past, and will speak up about their treatment, which is much easier with social media.

Explainability and transparency could be challenged by regulators and the public. Consumers deserve to know why their expected risk of loss has changed. Leadership on market conduct and fair treatment of consumer issues provided by the Canadian Council of Insurance Regulators is typically triggered when a practice is adopted across most of the industry and then challenged as unfair by consumers. These conversations are well managed but would be less disruptive if they could start earlier. A concern is the absence of a forum where industry leaders can work together with key stakeholders to acknowledge, anticipate, and resolve issues. The Property and Casualty Insurance Corporation (PACICC) was established more than 30 years ago to protect insurance consumers in the unlikely event that a company fails. PACICC could evolve to also assume responsibility of determining consumer acceptability of evolving insurance practices and as a centre to showcase best industry practices.

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45   Kovacs, "Cyber Risks Report 2019."
46   Kovacs, "Cyber Risks Report 2015."

Six critical questions
Why should insurers
expect increased attention
from regulators?

*"We're charged by Congress
with regulating financial
institutions. We take that mission
very seriously. We are tough
supervisors and regulators."*

— JANET YELLEN

The application of machine learning, artificial intelligence, and big data analytics is presently under active study by insurance supervisors in Canada and elsewhere. They seek to understand how insurers and other financial

Association will monitor the implications for auto insurance rate filings. Other regulatory organizations will supervise cyber security, fraud, money laundering, and other risks.

David Collingridge, in his 1980 book *The Social Control of Technology*, sets out the "Collingridge dilemma": The impact of new technology cannot be predicted until it is in wide use, but regulatory oversight of the technology is no longer possible when it has become entrenched. Larry Downes' 2009 book, *The Laws of Disruption*, sets out the "pacing problem," which argues that technology changes exponentially, but social, economic, and legal systems change incrementally. Technological innovation often outpaces the capacity of regulators to keep up. One solution to these issues involves prohibiting or curtailing innovation until proponents can prove that the changes will not cause harm. This interpretation of the precautionary principle has been widely criticized, but it nevertheless provides insight into the challenges facing regulators responsible for protecting consumers from harm.

institutions plan to use these emerging tools to provide appropriate oversight and consumer protection. AI and data science will also be important to support continuous improvement in supervisory practices.

Regulatory interest is widespread, although there has been little early regulatory action to address the application of AI or big data analytics in Canada. Federal and provincial privacy regulators are working to modify their current activities. The Office of the Superintendent of Financial Institutions (OSFI) has adopted a prudential perspective to the supervision of AI and big data issues, including a focus on operational risk. Members of the Canadian Council of Insurance Regulators are expected to address planned changes from a market conduct and consumer fairness/explainability perspective. The Canadian Auto Insurance Rate Regulators

While most regulators have expressed their commitment to address AI and big data, the near absence of early action is surprising. International experience suggests that monitoring and preparation in Canada will soon result in regulatory action. The various Canadian regulators are informed by a continuing stream of advice provided by the OECD, the International Association of Insurance Supervisors (IAIS), and others, including regulatory changes applied to the banking sector. The OECD has set out principles for the responsible implementation of AI. IAIS reports on the experience of insurance regulators around the world as they address AI and the digital economy. AI and big data analytics have a high profile within the Canadian and international regulatory community.

A consistent message involves regulators looking to understand and judge the social acceptability of new practices introduced by financial institutions. Regulators seek evidence that the application of AI and analytics will benefit consumers.

A consistent message involves regulators looking to understand and judge the social acceptability of new practices introduced by financial institutions. Regulators seek evidence that the application of AI and analytics will benefit consumers. Some, like the OECD, have endorsed the concept of regulatory sandboxes and innovation hubs, where new approaches can be tested before their widespread application. Indications of flexibility and awareness of the benefits are consistently followed by statements of concern about the risk of harm to some insurance consumers and warnings about the potential for intervention. Swiss Re observes, "the regulatory framework will play an important role in shaping the integration of new technology into the insurance space."[47]

Prudential regulation

In 2016, Autorité des Marchés Financiers (AMF) established the AMF Fintech Group, which now has more than 60 employees. The lab helps the regulator better understand the new technology used by financial institutions in Quebec and identify circumstances where these tools should be applied by the regulator to improve its own practices. AMF is working to support industry innovation, provide effective guidance to financial institutions, and modernize its supervisory operations.

In late 2020, OSFI initiated consultations that included AI and analytics and released a discussion paper: "Developing Financial Sector Resilience in a Digital World: Selected Themes in Technology and Related Risks."[48] The paper focused on cyber security, advanced analytics (including AI and machine learning), third-party ecosystems, and data. These issues were framed as operational risks that must be addressed to ensure the safety and soundness of financial institutions. The benefits of advanced analytics, digital technology, and innovation are mentioned in the paper, while the focus of the consultation is on managing risk. Nine risks set out in the paper include the following:

- Confidentiality
- Availability
- Integrity
- Soundness
- Explainability
- Accountability
- Transparency
- Reliability
- Substitutability

The paper indicates that "OSFI believes that its existing model risk guidance remains relevant, but could be better aligned and strengthened to address increased use of advanced analytics." This suggests oversight of property and casualty insurance practices that may be distinct from that applied to banks and life insurance companies. Also, prudential oversight of companies actively committing to emerging technologies may differ from the supervision of companies less involved in these issues.

It has been common for OSFI to develop initial guidance for the major banks that is later modified for life insurance companies and, eventually, general insurance. Discussion is traditionally followed with guidance about expected company practices and increasing requests for reporting. Assistant Superintendent Jamey Hubbs noted that "AI presents challenges of transparency and explainability, auditability, bias, data quality, representativeness and ongoing data

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47   Swiss Re, "Data-driven insurance," page 23.

48   OSFI, "Developing financial sector resilience in a digital world: Selected themes in technology and related risks."

> "If you're creating models that can't be explained to regulators, you shouldn't be using those models."[50]

governance."[49] The CEO of Concentra, Don Coulter, said, "if you're creating models that can't be explained to regulators, you shouldn't be using those models."[50]

OSFI Superintendent Jeremy Rudin has spoken about how data science can and should be applied to improve the supervision of financial institutions. He believes that solvency supervision that relies predominantly on judgment and experience can be improved by adding learning from the application of data science. He noted that "my colleagues and I already do considerable data analysis. By combining increased computing power with more granular data, we can increase the speed, accuracy, and level of detail of our existing analysis."[51] Rudin views data science as the opportunity to further develop current tools. He found that existing tools, however, are not set up to explain why they predict what they predict: "I am a prudential regulator, I am not in the prediction business, I am in the prevention business...What I need to know is the most likely causes of future failure...The algorithm does not know that there is anything wrong with these cases; it just knows that they stand out in some way. That said, these cases might be good candidates for further investigation."[52]

Assistant Superintendent Ben Gully spoke in early 2020 about OSFI's supervision of operational resilience and management of non-financial risk by Canada's banks. The discussion paper addresses supervision of artificial intelligence and machine learning models, cyber security, use of cloud services, and the role of culture and conduct.[53] Guidance about supervision of technology

risks, data management practices, and analytics by insurance companies in Canada is certain to follow in the near future.

Assistant Superintendent Neville Henderson said, "We get a lot of questions around AI and what we are to do about it." He added, "We really are a trust and verify regulator. We believe you. It's a great system, I am sure, but you have got to show us...we have to have an independent review to satisfy us that the system does what it says it does and it's accurate and companies don't do something that could be systemically discriminatory."[54]

Market conduct regulation

The Canadian Council of Insurance Regulators (CCIR) has set out formal expectations about the fair treatment of insurance customers.[55] Insurance companies are ultimately responsible to ensure the fair treatment of consumers. The guidance also sets out expectations for brokers, MGAs, and other industry intermediaries. Insurers and intermediaries are obliged to ensure there is no conflict of interest by always putting consumer interests ahead of their own interests. Insurers are expected to disclose relevant conditions, exclusions, restrictions, and fees of particular significance.

Work by the CCIR on fair treatment was independent of industry development toward the application of AI and analytics. There was convergence in the approaches developed by the CCIR and those developed in Ontario, but remaining differences warn that it can be difficult to secure consensus on regulation of critical issues that will affect the adoption and acceptance of new technologies in the insurance industry across Canada.

49   Zochodne, "What's in the Black Box?"
50   Ibid.
51   Rudin, "Data Science and the Future of Financial Supervision."
52   Ibid.
53   OSFI, "Developing financial sector resilience in a digital world: Selected themes in technology and related risks."
54   Meckbach, "Why solvency regulator is concerned about 'black box' underwriting."
55   Canadian Council of Insurance Regulators, "Fair Treatment of Customers Working Group."

The CCIR's 2020–2023 strategic plan is built around three strategic themes in the insurance sector:[56]

- Technological innovation
- Climate change and natural catastrophes
- Conduct and culture

The CCIR observes with its first strategic theme that "the need persists for appropriate supervision of processes, products and institutions in an evolving insurance marketplace characterized by accelerating innovation, shifting consumer demands, new products and related vulnerabilities including cybersecurity. Advancements in other markets, such as development of autonomous vehicles and advances in bioscience, may alter that traditional insurance product."[57]

Auto rate regulation

Analytics will improve the understanding of the frequency and severity of collisions for Canadian drivers. Larger volumes of data and increased capacity to process this information will improve the predictive power of models. In jurisdictions without rate regulation this information will be used by insurers to improve the coverage provided to drivers. On renewal, low-risk drivers would be offered similar coverage at a lower rate.

Insurers should be able to explain to some consumers why price increases are required, for example, as the result of an at-fault collision or in response to the rising cost of repairs for vehicles with sensors.

In several provinces, auto insurers must regularly file extensive analyses to secure approval to adjust rates. This information is processed by rate regulators, resulting in feedback to companies. It is unclear how improving the capacity to assess risk will be applied in jurisdictions with rate regulation. Regulations about acceptable rating criteria limit the information that can be included in filings. This interference may increase the number of drivers forced into the Facility Association, which limits the capacity of insurers to reduce rates paid by low-risk drivers. Ongoing discussion will hopefully open pathways so drivers in jurisdictions with rate regulation can benefit from the new analytical tools.

Recent experience in Alberta warns of industry challenges that may occur with the increased use of analytics. The superintendent of insurance in that province issued fines on 16 companies for overcharging consumers. Media coverage sought information about the size of the refunds provided to drivers and explanations about why companies failed to comply with established rate approvals. One company spoke about system errors, and another identified a technical error.[58]

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56   Canadian Council of Insurance Regulators, "Strategic Plan 2020–23," page 6.
57   Ibid.
58   Labby, "16 Insurance Companies Fined More than $1.5 Million for Overcharging Alberta Motorists."

International guidance for big data analytics

The IAIS set out advice for the regulation of the use of big data analytics in the insurance industry.[59] The direction set out by the IAIS can influence practices in Canada, and the IAIS reports at length about the risks for insurance consumers of AI and analytics. They urge supervisors to learn about the benefits and risks presented by rapid advancements in analytics so they develop appropriate responses to promote and encourage the industry to consistently deliver fair outcomes for consumers. They advise regulators to consider independent audit and integrity checks of machine learning and algorithm processes to ensure fair outcomes for insurance consumers.

The IAIS warns that granular customization may provide more product availability, but some customers may find themselves facing higher premiums or not being offered coverage at all. In Canada, for example, some condominium owners are presently adversely affected by the reduced availability or affordability of insurance. The IAIS is concerned that disruption in availability or price would become evident for segments of the population as a result of AI and analytics, resulting in decreased consumer confidence in the insurance sector.

They also warn of the risk that consumers may be harmed when insurers make decisions based on data not provided directly by consumers that may be incomplete or inaccurate. If customers are not aware these data are being used for insurance purposes, they would not have an opportunity to correct inaccuracies. Supervisors are encouraged by the IAIS to consider "how best to mitigate any potential prejudice to consumers as a result of the use of this type of alternate data for insurance purposes."[60]

International guidance for artificial intelligence

The OECD has published principles for the use of AI.[61] The IAIS also provided advice about the increasing use of digital technology in the insurance industry independent from advice about analytics.[62] Digital technology includes artificial intelligence, robo-advice mechanisms, and other emerging tools.

Here are the OECD's recommendations, which identify **five complementary values-based principles for the responsible stewardship of trustworthy AI**:

- AI should benefit people and the planet by driving inclusive growth, sustainable development and well-being.

- AI systems should be designed in a way that respects the rule of law, human rights, democratic values and diversity, and they should include appropriate safeguards—for example, enabling human intervention where necessary—to ensure a fair and just society.

59   IAIS, "Issues Paper on the Use of Big Data Analytics in Insurance."
60   Ibid., page 36.
61   OECD, "The Impact of Big Data and Artificial Intelligence (AI) in the Insurance Sector."
62   IAIS, "Issues Paper on Increasing Digitalisation in Insurance and Its Potential Impact on Consumer Outcomes."

- There should be transparency and responsible disclosure around AI systems to ensure that people understand AI-based outcomes and can challenge them.

- AI systems must function in a robust, secure and safe way throughout their life cycles and potential risks should be continually assessed and managed.

- Organisations and individuals developing, deploying or operating AI systems should be held accountable for their proper functioning in line with the above principles.[63]

In addition, the OECD put forth **seven key requirements that AI systems should meet in order to be deemed trustworthy**:

- **Human agency and oversight:** AI systems should empower human beings, allowing them to make informed decisions and fostering their fundamental rights. At the same time, proper oversight mechanisms need to be ensured, which can be achieved through human-in-the-loop, human-on-the-loop, and human-in-command approaches.

- **Technical robustness and safety:** AI systems need to be resilient and secure. They need to be safe, ensuring a fall back plan in case something goes wrong, as well as being accurate, reliable and reproducible. That is the only way to ensure that also unintentional harm can be minimized and prevented.

- **Privacy and data governance:** besides ensuring full respect for privacy and data protection, adequate data governance mechanisms must also be ensured, taking into account the quality and integrity of the data, and ensuring legitimised access to data.

- **Transparency:** the data, system and AI business models should be transparent. Traceability mechanisms can help [in] achieving this. Moreover, AI systems and their decisions should be explained in a manner adapted to the stakeholder concerned. Humans need to be aware that they are interacting with an AI system, and must be informed of the system's capabilities and limitations.

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63   OECD, "The Impact of Big Data and Artificial Intelligence (AI) in the Insurance Sector," page 20.

- **Diversity, non-discrimination and fairness:** Unfair bias must be avoided, as it could have multiple negative implications, from the marginalization of vulnerable groups, to the exacerbation of prejudice and discrimination. Fostering diversity, AI systems should be accessible to all, regardless of any disability, and involve relevant stakeholders throughout their entire life circle.

- **Societal and environmental well-being:** AI systems should benefit all human beings, including future generations. It must hence be ensured that they are sustainable and environmentally friendly. Moreover, they should take into account the environment, including other living beings, and their social and societal impact should be carefully considered.

- **Accountability:** Mechanisms should be put in place to ensure responsibility and accountability for AI systems and their outcomes. Auditability, which enables the assessment of algorithms, data and design processes, plays a key role therein, especially in critical applications. Moreover, adequate and accessible redress should be ensured.[64]

The IAIS recognizes the potential for digitization to improve the outcomes for insurance consumers and reduce insurance costs. Nevertheless, the focus of the advice is on supervision to prevent the unfair treatment of consumers in the design, underwriting, pricing, marketing, claims resolution, and ongoing management of consumers. "Supervisors will need to balance the risks of new innovations against the benefits for policyholders and the insurance sector as a whole."[65]

Supervisors are encouraged to develop a thorough understanding of how innovation works and is applied "to ensure proper assessment of new product business models, and the design and functioning of IT architecture, infrastructures and processes,

and how this is catered for in the insurers' risk management framework."[66]

They advise regulators to "develop new tools and skills for supervision of digital insurers, enhanced cooperation with financial and other authorities, safeguarding the supervisory perimeter to prevent regulatory arbitrage and enhancing information security."[67]

Finally, they encourage supervisors to "consider establishing guidelines for appropriate and responsible use of new technologies to safeguard the fair treatment of customers and—for example in the use of AI and robo advice mechanisms—promote advice and services that are suitable and affordable for the consumer."[68]

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64   OECD, "The Impact of Big Data and Artificial Intelligence (AI) in the Insurance Sector," page 21.
65   IAIS, "Issues Paper on Increasing Digitalisation in Insurance and Its Potential Impact on Consumer Outcomes."
66   Ibid.
67   Ibid.
68   Ibid.

Transition to a digital world increases the risk that insurance consumers misunderstand the regulatory protection in place.

Regulatory arbitrage

Some emerging products have effects similar to insurance but fall outside of the jurisdictional powers of insurance regulators. In these cases, consumers would not be provided with market conduct and prudential protection. If, for example, there is no assessment seeking to identify or measure damage nor a promise of indemnity, this product is not insurance. Nevertheless, it may be presented to homeowners as insurance, and consumers may have an expectation that they will be protected like someone purchasing coverage from a licenced insurance provider.

these requirements. Transition to a digital world increases the risk that insurance consumers misunderstand the regulatory protection in place.

Options for self-regulation

In 2019, the Chartered Insurance Institute based in the United Kingdom published "Digital Ethics: A Companion to the Code of Ethics."[69] The code sets out obligations and responsibilities for insurance professionals as they consider issues that include artificial intelligence and big data analytics.

There is scope for the insurance industry in

Some guidance set out by the institute includes:

- What would someone from outside of the profession think of what I am doing?

- Reflect not only on what you "could do" but what you "should do"

- The difference between the two can be where ethics lies and trust is built

- Put the best interests of each client at the heart of the decisions you take

- Reflect on the different perspectives of fairness that exist

Regulatory arbitrage may be definitional, as illustrated above, or jurisdictional. Some consumers in Canada purchase insurance coverage that is available through the Internet but not authorized locally. Consumers may be unaware that products available for direct purchase are not sanctioned where they reside. Providers, however, should understand the risks they accept and deny coverage in unapproved jurisdictions, but regulatory oversight will be difficult. These challenges increase for consumers who do not have support from a broker or agent. Moreover, some fintech start-ups may be unaware of existing regulations or, as boldly modelled by Uber, may choose to purposely ignore

Canada to provide leadership to promote the acceptance and adoption of new technologies to better serve consumers. A credible strategy must acknowledge and focus on resolving the risks facing consumers. For example, in response to growing concerns by regulators and consumers about the use of credit scores by insurers, the members of the Insurance Bureau of Canada developed a code of conduct to provide guidance to the industry. The guide discusses consumer consent, use of current information, a commitment to protect confidential information, and handling of disputes. Moreover, the guide includes a commitment that an insurer will not deny, cancel, or decline renewal of a policy solely on the basis of credit information.

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69   Chartered Insurance Institute, "Digital Ethics: A Companion to the Code of Ethics."

Lessons for the insurance industry

Insurance regulators across Canada are expected to become increasingly involved in the supervision of the application of artificial intelligence and analytics in the insurance industry. OSFI, AMF, and BCFSA are likely to coordinate their efforts to enhance prudential oversight and supervision of operational risk. Members of the Canadian

The regulatory environment for the insurance industry to introduce AI and analytics is unclear, likely to change, and may include conflicting expectations. The tone set by the International Association of Insurance Regulators and specific regulators, like the Financial Services Authority in the UK, implies considerable challenges for those in the insurance industry looking to embrace AI and big data analytics. Regulators would be

> There will be a risk of conflicting expectations for market conduct and privacy regulation, and possibly between prudential and cyber security regulation. The industry will need to be proactive to champion the value of consistent supervisory expectations.

Council of Insurance Regulators will work to coordinate change in market conduct regulation, but differences in approach may become evident across the country. Oversight of privacy, cyber security, and rate regulation are expected to remain largely independent from prudential and market conduct regulation, unfortunately with few examples of cooperation and coordination. There will be a risk of conflicting expectations for market conduct and privacy regulation, and possibly between prudential and cyber security regulation. The industry will need to be proactive to champion the value of consistent supervisory expectations.

Growing regulator interest and action may slow the pace and scope of industry innovation. Regulators are technologically agnostic, but also frequently cautious about change. Their first priority is to ensure solvency and sound market conduct. Insurance regulators seek to protect consumers from risk and are often skeptical of change, including new technology. They seek proof that new approaches will not harm consumers—proof that may be difficult to demonstrate. The industry will need to continue to champion innovation and the benefits to consumers. Regulatory sandboxes and innovation hubs are approaches that have been applied successfully in other jurisdictions.

expected to play a less-intrusive role if the industry demonstrates that recognized risks are effectively managed and consumers are confident that they will be treated fairly. It is important that the Canadian insurance industry get ahead of potential regulatory and consumer issues, perhaps by establishing a forum where these concerns can be discussed and resolved. Industry leaders committed to technological innovation will want to support awareness of local and international initiatives working to advance the benefits of responsible AI and analytics and organizations like the Future of Life Institute that support advances in AI ethics.

Application of AI and analytics will improve the operations of insurance supervisors. Regulators will need to compete with insurance companies to secure skilled analysts. Analytics can be applied to better identify risky behaviour and trigger early regulator intervention. These tools can also be taught to provide assurance when company practices are sound and less intrusive oversight is warranted. Increased use of the emerging tools by regulators will improve regulation, better serve consumers, and build confidence in the financial health of the insurance industry.
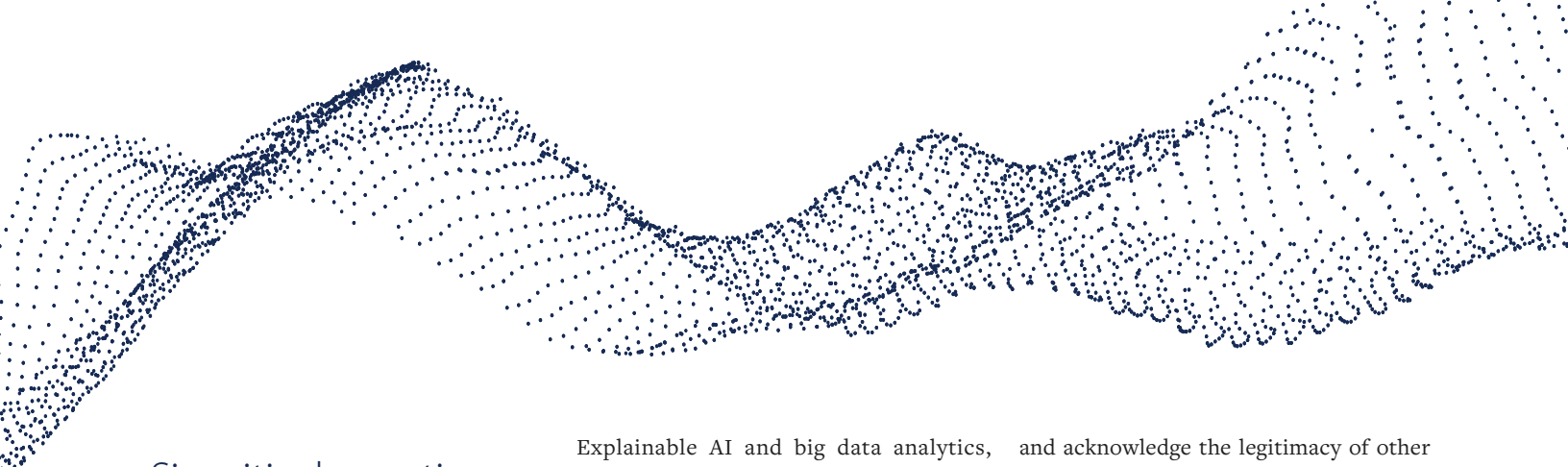
Six critical questions
Why must insurers focus
on better outcomes
for consumers?

*"We had three big ideas at
Amazon that we've stuck with
for 18 years, and they're the
reason we're successful. Put the
customer first. Invent. And be
patient."*

— JEFF BEZOS

Explainable AI and big data analytics, implemented responsibly, hold great potential to better serve insurance consumers. But will the industry get this right? Industry experience dealing with millions of customers over many decades finds scope for improvement. An industry disrupter speaks about re-establishing insurance as a social good instead of a necessary evil.[70] Insurance is viewed by some as unpopular and needlessly complex. Some consumers, regulators, and others do not understand decisions made by insurance companies, adjusters, agents, and brokers when they offer coverage or resolve claims. This may be evident from the customer's first experience of learning that there may be large, inexplicable differences in the price various insurers charge to assume their risk. Unexpected changes in pricing or conflicts in resolving a claim can erode consumer trust, a serious concern for an industry founded on trust.

Concern about trust in institutions, including insurance companies, is expected to be magnified in the digital age.[71] Insurance professionals are willing to commit to the fair treatment of insurance customers, supported by the introduction of tools with greater capacity to assess the individual risk of loss. There are, however, different perspectives about what is fair. The important debates about the fair treatment of customers often involve conflicting views of fairness. These conflicts are likely to grow in importance as the financial sector increasingly presses forward with the introduction of powerful tools based on actuarial and statistical fairness. Insurance leaders must understand and acknowledge the legitimacy of other perspectives of fairness.

The application of artificial intelligence and big data analytics increases the ability of the insurance industry to quantify risk of loss at a granular level. Pricing and coverage decisions will be informed by better knowledge about risk, increasing the industry's capacity to ensure actuarially or statistically fair treatment of consumers. Skill to quantify the risk of loss, statistically fair pricing, and availability of coverage across society is a powerful mechanism to help society manage risk. Will implementation of artificial intelligence and analytics result in better outcomes for insurance consumers? Will improvement be expected for some consumers or for everyone? Is there a company or industry plan to support customers that may be worse off? The risks are found in the details. It will be important that a focus on consumers is applied to every aspect of the many specific elements of the transition.

A proud history

Insurance exists to serve the risk management needs of society. The insurance industry has much to be proud of. Millions of Canadians have been made whole following a loss. Risks for participants in a group are pooled. Most participants will not experience a loss, but the revenue in the pool must be sufficient to pay for the losses that some are expected to incur, including a few losses that may be large. Assessing a fair premium is dependent on the expected frequency and severity of losses. Insurance is the promise to participating

The application of artificial intelligence and big data analytics increases the ability of the insurance industry to quantify risk of loss at a granular level.

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70   Azhar, "Disrupting the Insurance Industry with AI."
71   Kovacs, "Sharing Economy: Implications for the Insurance Industry in Canada."

consumers that they will be made whole if they experience a loss.

Risk pooling is a powerful mechanism. Widespread use of insurance has accelerated its development in advanced countries around the world, including Canada. It is hard to imagine a world without insurance to help society and decision makers manage critical risks. How would society cope with the risk of ruin from catastrophic loss? The expectation of support from the insurance industry is embedded in decision making across society.

in participation in a pool. Capacity in the industry to measure and assess individual risks was very limited. Coverage included fire protection services through insurance company fire brigades that would respond and suppress fires.

Over time, insurance pooling concepts supporting marine and fire insurance were applied to the development of additional coverage to serve consumers. This included auto, business, and other insurance products. Modest fees paid by many participating in a group were pooled to compensate the losses experienced by a few. This was

The insurance industry has a proud and distinguished history of providing consumers with protection across a growing number of perils through the provision of pools and the active championing of risk reduction.

Informal risk pools were present in prehistory. If a home were destroyed by fire, for example, it was understood that neighbours would work together to rebuild the structure and help replace the contents. When passing through difficult waters, merchants would redistribute their cargo across several ships to limit the risk of catastrophic loss if a single vessel should capsize. These concepts provide the foundation for property and marine insurance.

More formal risk pools emerged over time. Early merchants seeking to borrow funds to finance trading voyages to distant lands secured loans that were bundled with a guarantee that a repayment would be cancelled if a shipment were lost at sea. Additional charges for loans to support commerce by sea relative to goods carried by land were condemned by Pope Gregory IX in 1236 as usury, so practices further evolved toward those found in modern marine insurance.

Current property insurance practices emerged following the Great Fire of London in 1666. Early fire insurance pools focused on the identification of groups with similar risk of loss, typically property owners located in the same community, who were interested

a sound business model for insurance companies and welcome protection for risk-averse consumers facing a range of risks. The insurance industry has a proud and distinguished history of providing consumers with protection across a growing number of perils through the provision of pools and the active championing of risk reduction.

Classification of risks

The pooling of risk for a group of customers begins with the identification of individuals with similar risk of loss to be included in the group—that is, risk classification. Past experience for the group is coupled with an analysis of trends to anticipate future losses and establish actuarially fair pricing. The expected average experience for the group is applied to the specific circumstance of individual risks. Big data analytics increases the capacity for insurers to anticipate the risk of loss.

Each customer is unique. Concepts like the law of large numbers finds overwhelming uncertainty in small groups and robust outcomes for larger groups. Insurance actuaries find that "to the extent that the risk classification process attempts to identify

and measure every characteristic, it becomes unworkable."[72] Nevertheless, it is important that insurance practices take into account some of the known differences in individual risk characteristics. The difficulty in risk classification involves determining a fair balance. The Casualty Society of Actuaries observes that "most of the controversy surrounding risk classification involves where the lines are drawn."[73]

American, severely limiting the availability of loans and insurance coverage to people in these communities.[75] The use of age and gender as rating criteria by auto insurers in Canada has been challenged many times over the past 40 years, including a Supreme Court ruling urging the industry to develop data that would support the application of non discriminatory criteria. Use of credit scores is a more recent controversy for the industry.

Actuaries have established five principles to achieve these objectives:

- The system should reflect expected cost differences.
- The system should distinguish among risks on the basis of relevant cost-related factors.
- The system should be applied objectively.
- The system should be practical and cost effective.
- The system should be acceptable to the public.[74]

The objectives of risk classification are to ensure financial soundness, be fair, and provide incentives for risk reduction that result in the widespread availability of coverage.

The insurance industry should anticipate and welcome public debate that serves to determine acceptable industry practices for risk classification. For example, banks and insurers in the United States were confronted in the 1960s about practices that resulted in the redlining of high-risk communities that were largely African

Joi Ito argues that "the original idea of risk spreading and the principle of solidarity was based on the notion that sharing risk bound people together, encouraging a spirit of mutual aid and interdependence. By the final decades of the 20th century, however, this vision had given way to the so called actuarial fairness."[76] He goes on to state that "computer scientists of today are more sophisticated in many ways than the actuaries of yore, and they often sincerely are trying to build algorithms that are fair. The new literature on algorithmic fairness usually doesn't equate fairness with

"The original idea of risk spreading and the principle of solidarity was based on the notion that sharing risk bound people together, encouraging a spirit of mutual aid and interdependence. By the final decades of the 20th century, however, this vision had given way to the so called actuarial fairness."[76]

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72   American Academy of Actuaries Committee on Risk Classification, "Risk Classification Statement of Principles," page 1.
73   Ibid.
74   Ibid., page 5.
75   Ito, "Supposedly 'Fair' Algorithms Can Perpetuate Discrimination."
76   Ibid.

accuracy, but instead defines various trade offs between fairness and accuracy."

Access to enormous datasets and emerging data science tools is shifting the capacity of the industry to reclassify individual risks. Consideration of change should be accompanied by open discussion about the acceptability of evolving insurance practices. Industry practices can be adapted to achieve broader social goals when clear direction is provided. Insurance practices must be fair and be seen to be fair.

Consumers' views of fairness

Risk classification is one of many factors that affect consumer perceptions about the insurance industry and fairness. Claims resolution, distribution, marketing, and many other practices influence consumers. Consumers will judge practices and changes across the entire system.

For example, in 1992 Hurricane Andrew resulted in damage claims in Florida that significantly exceeded industry expectations. Some insurance companies became insolvent. A new understanding of the risk of hurricane damage claims resulted in several insurers withdrawing from the market while the rest sought significant price increases. Consumer frustration and anger about this disruption has been intense for more than 25 years. Debate about the fair treatment of insurance customers often focused on ensuring that affordable coverage would be available. Regulations were introduced detailing steps to minimize the disruption for consumers if insurers withdraw from the market.

Insurance is a competitive business. Companies are driven to develop the capacity to better identify and assess the risk of loss. Leaders who demonstrate a superior capacity to understand, select, and properly price risk can successfully sustain profitable growth.

AI and big data analytics will further improve industry capacity to assess the risk of loss. This will benefit customers with low risk. A fair premium for low-risk consumers to participate in a pool is reduced when high-risk consumers contribute more or stop participating. Insurance companies can offer low-risk consumers the same level of protection at a lower price, and this change is sustainable if a new assessment tool is proven to be superior in assessing risk.

A new approach that benefits lower-risk consumers will invariably harm those members in a group with higher risk. These higher-risk drivers, property owners, and businesses must pay more to secure the same level of coverage. Indeed, some insurers may choose to withdraw the offer of coverage. Customers newly identified with higher risk will not be pleased with the change. They may be more understanding if the change results from a clearly identified action where they were responsible, like an at-fault collision. Also, they will appreciate it if there is a clear path to re-establish themselves as lower risk. Consumer satisfaction increases when they are able to control the relationship with their behaviour and practices.

Consumers deserve an explanation if the assessed risk of loss has increased. Vehicle owners are required by governments to

A new approach that benefits lower-risk consumers will invariably harm those members in a group with higher risk. These higher-risk drivers, property owners, and businesses must pay more to secure the same level of coverage.

purchase insurance, and property owners are required to purchase insurance by lenders. The universality of insurance differs from most industries. Consumers *must* find insurance coverage, and they will want to understand change in the assessment of their risk of loss.

The insurance industry in Canada is subject to extensive regulation. This includes prudential supervision to assess capacity to pay claims, governance practices, and solvency risk management. Importantly, the insurance industry is also subject to regulation of market conduct, including a focus on the acceptability of industry practices. Market conduct regulation seeks to assure consumers and other stakeholders that industry practices are transparent and fair. Independent supervision of industry practices by regulators is critical to building consumer trust.

with public authorities about how to best address the needs of those with high risk where affordable private residential flood insurance is difficult to introduce.

Many years ago, improving capacity to identify drivers with a higher risk of loss resulted in concerns about the affordability and availability of coverage for high-risk drivers. This a predictable outcome of company and public policy efforts to identify and reward lower-risk drivers. It was important that the industry was able to partner with policymakers and regulators to develop risk pools to support vehicle owners who temporarily did not qualify for mainstream coverage.

Raj Shroff concludes that "AI has the potential to transform the insurance experience for consumers from frustrating and bureaucratic to something fast, on-demand and more affordable. Tailor-made insurance products

Market conduct regulation seeks to assure consumers and other stakeholders that industry practices are transparent and fair. Independent supervision of industry practices by regulators is critical to building consumer trust.

Public acceptability of tools that better identify and benefit those with low risk must include consideration of the treatment of those with high risk. This mindset was adopted by the insurance industry in Canada with the introduction of overland residential flood insurance. Circumstances for homeowners with low to moderate risk of overland flooding were improved when private flood insurance was introduced and soon became widely available. This was accompanied by the launch of discussions

will attract more customers at fairer prices...We will see insurance become more personalized, because insurers using AI tech will be able to understand better what their customers need...Most importantly, the AI solutions described above can make it easier for customers to interact with insurance companies."[77]

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77   Schroff, "How Are Insurance Companies Implementing Artificial Intelligence (AI)?"

Fraud Prevention

Early fraud detection

Operations

Saving time

AI in Insurance

Customer Analysis

Tailored & cheaper insurance

Claims Management

Faster claims processing
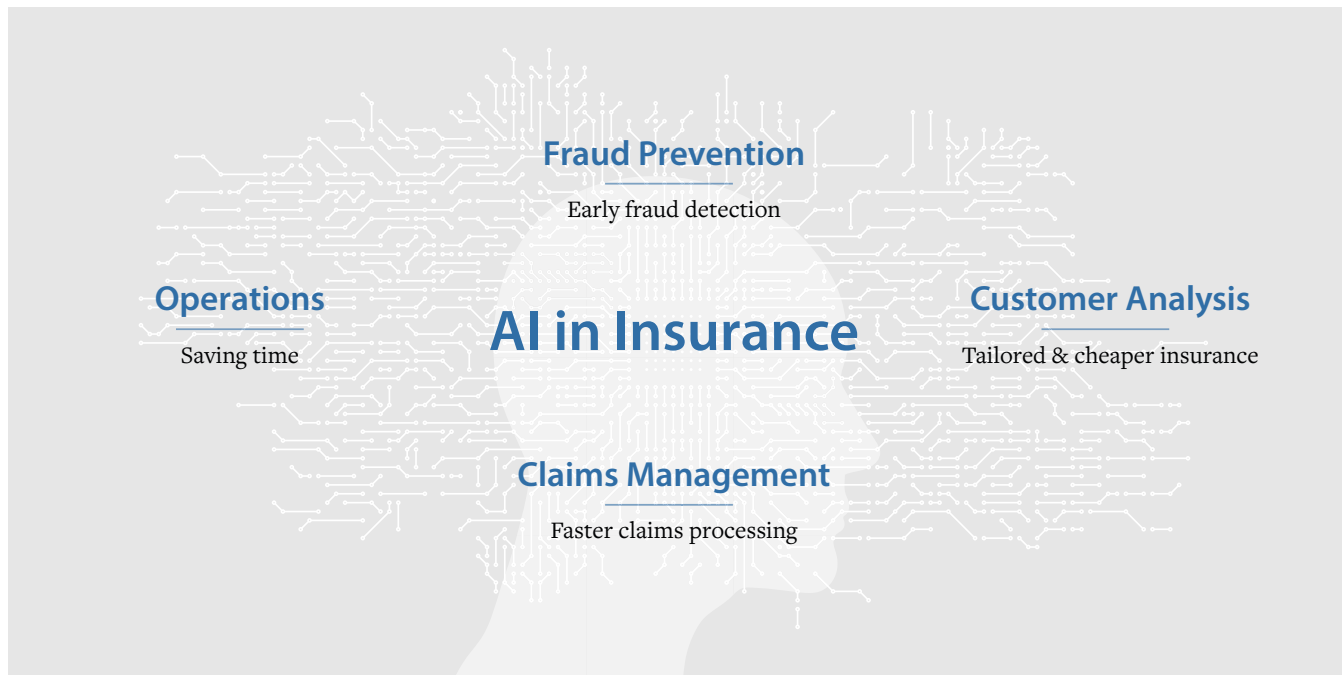
Source: Schroff, "How Are Insurance Companies Implementing Artificial Intelligence (AI)?"

Lessons for the insurance industry

The insurance industry exists to serve its current and future customers. Changes that will become possible over the next 10 years because of the development of artificial intelligence and big data analytics should be assessed by an industry committed to introducing changes that will benefit consumers. Do not introduce changes simply because they are possible; make changes that are expected to benefit consumers.

Increased capacity to assess risks at a more granular level will benefit some members of a group and harm others in the pool. How will the benefits be shared and explained to those found to be at lower risk? What is the plan to support those found to be at higher risk? How was public acceptability assessed for new company and industry practices? Has the industry explained the changes introduced by AI and big data analytics to insurance regulators?

The near universal use of insurance by drivers, homeowners, and businesses means that inevitable changes from the application of AI and analytics adopted by the industry will be judged by consumers, regulators, and others. The industry should encourage and support informed debate about evolving insurance practices. The industry has demonstrated great capacity to adapt its practices if and when clear direction is provided.

Risk pools, statistically fair pricing of risk, and other benefits of insurance have served Canadians well. The insurance industry has much to be proud of as it works to protect drivers, homeowners, and businesses. Demonstration that emerging AI and big data analytics tools are used to benefit consumers must acknowledge and work to address alternate views of fairness. Third-party verification may demonstrate increased industry capacity to achieve statistical and actuarial fairness, but a broad perspective of fairness is critical to building consumer trust.

The near universal use of insurance by drivers, homeowners, and businesses means that inevitable changes from the application of AI and analytics adopted by the industry will be judged by consumers, regulators, and others.

Recommendations for the insurance industry

"I've learned that people will forget what you said, people will forget what you did, but people will never forget how you made them feel."

— MAYA ANGELOU

The insurance landscape is changing, empowered by growing access to digital information. Artificial intelligence and big data analytics are among the most powerful innovations that will affect the insurance industry over the next 10 years. They can organize billions of data points into clear insights, create personalized experiences, anticipate needs, and better manage risks facing drivers, homeowners, and businesses. When used responsibly these tools will improve lives and solve problems. Forward thinking and innovative insurers will use AI and big data to make insurance better for Canadians.

As the insurance industry embraces the power of this new technology it is important to reflect on the risks of adoption and acceptance. Consumers lack clarity about artificial intelligence and big data analytics, what they can do, and where opportunities and risks exist. Demystifying the issues is a step toward responsible implementation.

Here are eight recommendations for the insurance industry in Canada related to AI and big data analytics:

1. **Inform consumers:** Insurance consumers need to understand how the new tools will affect them. Big data analytics will increase the capacity of the insurance industry to assess individual risks at a granular level and this will benefit those with low risk of loss. The industry must be proactive to demonstrate that application of the new algorithms are statistically fair and unbiased in the treatment of all consumers, including planning for the needs of consumers that may face higher prices and reduced availability of coverage options.

2. **Embrace innovation:** Seek out opportunities to change traditional approaches to insurance. Celebrate the industry's proud history while encouraging new practices across the organization. New tools will support actions that were not possible in the past, and this is good for your company and for consumers. Think of AI and big data analytics not as business tools but as a commitment to innovation and modernization.

3. **Be prepared for uncertain regulation:** Deployment of artificial intelligence and big data analytics introduces many questions about the fair treatment of consumers, exclusion of coverage, and difficulty in obtaining a quote. It is the responsibility of insurance regulators to ask questions and provide guidance through this transition. The insurance industry should be prepared for detailed regulatory monitoring of change and for challenges to practices that cannot be explained. Transparent, open discussion is in everyone's best interests.

4. **Create new insurance programs:** Big data analytics can support the introduction of coverage for risks that were previously not insurable, like residential flood insurance. Demand can be created for new products in situations where consumers may be unaware of the risks they face. There is scope, for example, for the insurance industry to adapt coverages provided to large businesses and homeowners to better serve small businesses and tenants and to expand cyber insurance coverages.

5. **Doing it right:** Actions sincerely seeking to improve outcomes for policyholders will be supported by consumers. Do not be afraid to fail at first, as learning from the experience will move you toward a better solution. It will likely be more important to bring forward the right changes than being first to market. Consumers will likely understand if you are willing to acknowledge shortcomings and to move forward, learning to provide better solutions.

6. **Changing consumers:** Insurers need to demonstrate their understanding of the growing importance of environmental, equity, and social issues for consumers. Consumers are also increasingly comfortable with modern technology. Insurance has successfully adapted to extraordinary societal changes over more than 200 years in Canada. Insurers know how to adjust; they just need to become comfortable with doing so much faster.

7. **Invest in new technology:** Legacy systems can be a major stumbling block for insurers trying to embrace artificial intelligence and big data analytics. Leveraging digital process automation platforms can insulate the front office from the back office and provide the straight-through processing, flexibility, and digital capabilities insurers need today to be competitive and better serve consumers.

8. **Accept different views of fairness:** The insurance industry should be proud of the benefits to society of providing risk pools supported by systems that result in actuarially fair pricing. These approaches support risk management needs for drivers, homeowners, and businesses. Nevertheless, the industry must be prepared to participate in discussions about socially acceptable classification of risk where some participants adopt a perspective on the fair treatment of consumers that differs from an unfettered commitment to actuarial fairness.

There is no silver bullet solution that is certain to work across the insurance industry in support of the introduction of machine learning, artificial intelligence, and big data analytics. An insurer's product or investment selections must be made with the main goal of supporting and extending its core business strategy.

Insurers should focus on the following:

- **Data quality and management:** Insurers must actively manage data governance and quality for structured and unstructured data used to support decisions and operations.

- **Artificial intelligence:** AI can develop a more personal experience for policyholders. AI can give insurers greater ability to control and learn from client interactions. AI can also manage books of business by continuously monitoring performance.

- **Digital automation platforms:** Insurers need to select specific platforms, tools, and applications that enable digital processing, interface tools, and apps. Insurers are behind other industries in this transition and can learn from sectors that include banking, retail, and telecommunications.

- **Omni-channel experience:** Insurers need to interact seamlessly with the insured, broker, or adjuster on whatever device or app the user chooses. Whatever functions an insurer provides need to work across channels and enable users to seamlessly switch channels.

- **AI for decision support:** AI can do wonders to assist in many judgment calls that happen every hour of every day in insurance, like suggesting who is well-suited to respond to a new claim, choosing the best vendor to repair a damaged vehicle or home, or suggesting a repair flow or replacement.

Leading companies are pushing through these challenges to establish a better understanding of the risks facing consumers and the coverage that can be provided. Informed insurers grow more confident in the products and services they offer when supported by analytics. Data science and analytics provide a foundation for sound decisions about product design, pricing, and willingness to offer coverage.

Significant change is inevitable for the insurance industry. Full-scale disruption is unlikely in the near term, providing some time to adjust. Nevertheless, profound change is underway. Artificial intelligence and big data analytics will bring benefits for insurance consumers if companies deploy them with sufficient diligence, prudence, and care. The insurance industry should be excited by the opportunity to responsibly bring new ideas and approaches forward to better serve the risk management needs of Canadian consumers.

Appendix: AI terminology	
Term	**Description**
Algorithms	A list of computer-implementable instructions.
Machine intelligence	A collection of programs and processes that enable a machine (eg. computers) to apply data and information to solve problems.
Conventional and curve fitting	A basic form of MI (eg. generalised linear models). These rely on assumptions to understand how variables relate to each other, with the aim of *creating a curve that best-fits* the relationship between data points. Conventional curve fitting can capture some types of non-linear relationships, also.
Machine learning (ML)	Algorithms that learn from data and analyse more complex, inter-related and non-linear relationships among variables. Commonly used in classification, regression and pattern recognition.
Artificial intelligence	AI goes beyond ML by facilitating *adaptive application of understanding*. With these algorithms, machines can store and apply learning flexibly, including to contexts not originally intended.
Supervised learning	To train a machine *using data which are labelled*, ie. already tagged with the correct answer. These labelled data act as supervisor. The machine infers relationships from this sample, which are used to map new examples.
Unsupervised learning	Unsupervised learning is used when *labelled data are not available*. With no teacher to train the machine, it has to discover hidden structures in the unlabelled data on its own. Used for clustering and association.
Clustering and association	A clustering algorithm seeks to discover *inherent groupings* in the data, eg, grouping policyholders by purchasing behaviour. An association problem is when an insurer looks to find out *rules that describe* the data, eg. policyholders that buy X policy also tend to buy Y policy.
Reinforcement learning	Goal-oriented algorithms (agents), which answer the question, *how can this be optimised*? Eg. how can marketing investment be optimised to extract maximym ROI? Learns by interacting with its environment.
Ensemble learning	Uses multiple algorithms in combination to obtain better predictive performance than could be obtained from any one of the algorithms alone.
Data engineering	Data engineering is the process of collection, curating, storing, and transforming data for analytical purposes.
Deep learning	Imitates the human brain to learn without human supervision, with data that is unstructured and unlabelled.
False positive	A prediction which wrongly indicates that a particular condition or attribute is *present*.
False negative	A prediction which wrongly indicates that a particular condition or attribute is *absent*.
Physics-based ML	Machine learning that *incorporates a model (eg, hydrodynamic) built using a valid scientific theory based on physical systems understanding* into an ML algorithm/process to provide more structure to the model than would be the case for a less constrained ML model (eg, supervised or unsupervised learning.) This hybrid approach is often easier to interpret and diagnose.
Generative adversarial networks	Generative adversarial networks (GANs) involve learning patterns in data so that the model can generate new examples that seem credible enough to belong to the original dataset. The original data and the generated data can then be played off each other in the context of competing neural networks to develop better models.
Causal inference	Causal inference in ML refers to approaches that provide more structure for control and prediction by building capabilities that identify actual drivers of outcomes *to make an ML process more robust to changing circumstances*, eg, attempting to sort out causal drivers of obesity to distinguish what can be controlled across different sub-populations or analysing what design choices lead to more clicks on a website.

Source: Swiss Re Institute, *sigma* No 5/2020, page 2.

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