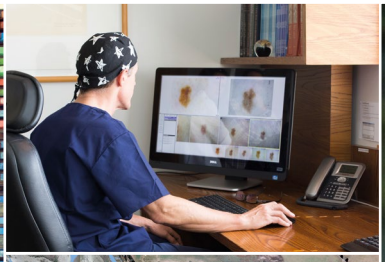
forum NEW ZEALAND

ARTIFICIAL INTELLIGENCE

Shaping a Future New Zealand



An Analysis of the Potential Impact and Opportunity of Artificial Intelligence on New Zealand's Society and Economy

digitalnation.nz

Figure 1 – New Zealand AI Landscape

Artificial Intelligence in New Zealand 2018

New Zealand has a thriving AI sector working with AI technologies at all levels. This ecosystem map – built up initially from work done on this research project – shows who's investing in, working with and thinking about the effects of Artificial Intelligence in New Zealand in 2018.

Things are moving very rapidly and we know this map will constantly evolve – if you've got a suggested addition, please let us know at *mapping@aiforum.org.nz* and we'll publish regular updates.

Produced By: forum NEW ZEALAND

Join the AI Forum NZ at *www.aiforum.org.nz/join-aiforum*

DESIGN BY FLUX NZ.COM

Version 1.2 March 2018


COMMERCIAL AI
wine-searcher
aura
INFORMATION SECURITY
POWERED BY KORDIA
9SPOKES
Panmure Orchards
AMY
The tutor who knows you
TRANSPOWER
ORION HEALTH
ANZ
KANTAR
community law
free legal help
throughout aotearoa
molemap
BY DERMATOLOGISTS
shopper360
Gentrack
bot
thebuilder
active associate
AIR NEW ZEALAND
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Dairy for life
AsureQuality
ohmio
booktrack
Soundtracks for Books
soul machines
made possible.
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NATURAL LANGUAGE GENERATION
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SLI SYSTEMS
Lotto NZ
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Engineering Professional Services
textferret
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TĀMAKI HERENGA WAKA
hmi
TECHNOLOGIES
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EXPERIENCE SMARTER
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IDEAS TO LIFE
TE WHARE WĀNANGA O TE ŪPOKO O TE IKA A MĀUI
VICTORIA
UNIVERSITY OF WELLINGTON

Data, References and Definitions

All the graphs in this study and the data used to create them can be freely accessed from *Figure.NZ*, a social enterprise, making it easier for everyone to find and use data about New Zealand.

Please download a free copy of this report from the AI Forum website, **www.aiforum.org.nz**

Acknowledgements

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Aaron Schiff (independent economist) and **Hayden Glass** (Sapere) for economic analysis and peer review.

Sandra Laws and the team from Ministry of Business, Innovation and Employment (MBIE) for providing an economic peer review and quality feedback.

The many staff from our project partners who took time to provide in depth reviews and feedback throughout the process.

Thank you to the many organisations that supported the research financially and by providing case studies.

First Edition – May 2018.

forum NEW ZEALAND

About the AI Forum of New Zealand

The Artificial Intelligence Forum of New Zealand (AIFNZ) sets out to raise the level of awareness and capabilities of Artificial Intelligence (AI) in New Zealand.

The rapid development of AI technologies presents major opportunities and challenges for our country: from creating world leading AI businesses, nurturing a pool of talented AI engineers, applying AI technologies to our Government, agriculture, manufacturing and service industries to holding a meaningful national debate on the broader implications for society, New Zealand needs to actively engage with AI now in order to secure our future prosperity.

The Forum brings together citizens, business, academia and the Government connecting, promoting and advancing the AI ecosystem to help ensure a thriving future New Zealand enabled by technology.

MEMBER OF:

TECH ALLIANCE

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SPACETIME AI-DRIVEN MARKETING
Intela AI Data Science - Added Intelligence
active associate
made possible.

Research Partners

IDC ANALYZE THE FUTURE
sapere research group

Data publicly available at

figure.nz

Introduction: AI Forum of New Zealand

Kia ora koutou

On behalf of all those involved, it is a great pleasure to see the publication of this landmark piece of AI Forum research.

Its purpose is to demystify this significant technological development and deliver a strong call to action to ensure that, as a nation, we are well positioned to address the impacts and opportunities that the adoption of Artificial Intelligence (AI) offers.

Through this research, we are pleased to see New Zealand taking the first steps towards building a cohesive national strategy to effectively address the mainstream changes AI will bring. From an international perspective, New Zealand has the opportunity to be in the vanguard of countries with a coordinated plan to maximize opportunities and manage the challenges of AI. The risks of not doing so in particular to our economic productivity and stemming a greater digital divide in society are significant. Other countries, including Canada, the United Kingdom (UK), China, Estonia, Singapore and most recently France are already investing strategically and making rapid advances. New Zealand needs to keep pace to ensure a position at the forefront of AI.

This report concludes with a series of recommendations which the AI Forum, in partnership, will endeavour to action. As a trusted independent body, the AI Forum will continue to facilitate the development of a cohesive national strategy, moderate national conversation and build next generation capability for New Zealand's future state sector and commercial developments. AIFNZ also supports the ongoing discussion of practical ethical and legal principles to safeguard the rights and ambitions of all New Zealanders in this environment of rapid technological change.

STU CHRISTIE
Chairperson
AI Forum of New Zealand

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With a project of this size and scale, it would not have been possible without support from many organisations. In particular, the AI Forum would like to thank its key supporters, notably the Ministry of Business, Innovation & Employment, NZTech and Platinum Research Supporters ANZ, ATEED, Google, IBM, and Microsoft. AIFNZ would also like to recognise and thank the many universities, technology firms and industry organisations that also helped enable this project.

Kāti ake i konei, "Enough said".

FOREWORD
New Zealand Government

Emerging and disruptive digital technologies continue to converge and while many of us have heard of 'Artificial Intelligence', this rapidly evolving technology ecosystem and its potential for economic transformation, is poorly understood.

Raising awareness and creating a greater understanding of how this technology will impact future economic growth and drive prosperity for all New Zealanders is an objective of the Ministry of Business Innovation and Employment.

The Ministry has provided foundational support to the AI Forum to undertake research. So much about the impact of AI is unknown, but in order to begin to understand how AI will influence our lives, we need to approach the discussion from an informed base.

Although the adoption of AI is very much in the early stages in New Zealand, many of us are already interacting with it. For example, machine learning algorithms power Netflix's and Amazon's product recommendations. Yet, many of us would not register this as AI.

Through our support of this research we hope to continue to dispel the myths surrounding AI and its adoption and to enable a wider dialogue to occur around how this transformative technology will impact both the New Zealand economy and society. We are also very conscious of the concerns and questions many New Zealanders will have about the impact of AI on their lives and jobs.

It is likely many jobs will be augmented by the introduction of AI, freeing up employees from the more mundane or rote tasks to allow them to tackle more complex and creative work, enhancing our unique human attributes, such as creativity, critical thinking and collaboration.

The future will demand new and different skill sets and will reinforce the concept of life-long learning. In order to support a more integrated digital and human workforce, government, educational institutions and business will all need to work together to ensure our workforce is adaptable enough to cope with this change. If jobs are lost to automation we must have the right support mechanisms in place to ensure re-skilling and re-training can occur.

CAROLYN TREMAIN
Chief Executive
Ministry of Business, Innovation & Employment

MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI

Long term I am very optimistic about the positive impact AI will have on the New Zealand economy. It will support the emergence of other technologies such as the Industrial Internet of Things also known as Industry 4:0, including connected and autonomous vehicles. The concept of Industry 4.0 has evolved from its early beginnings as solely a manufacturing initiative, to now include smart transportation and logistics, smart buildings, smart healthcare and even smart cities, all further enhanced by analytics. This to me is perhaps the most transformative effect of AI, the ability to support decision making and utilise data insights to a degree not imagined before.

Emerging technologies bring new challenges. Partnering with the sector and engaging more widely will both allow us to realise the opportunities provided by the technology, but to fully explore the 'social licence' issues surrounding the adoption of AI.

These conversations will help us ensure no one is left behind and that we all can benefit from this transformative technology. This research undertaken by the AI Forum is an essential first step.

FOREWORD
ANZ Bank New Zealand

How we choose to utilize AI across our businesses, in Government and throughout society will impact how New Zealand progresses as a nation.

ANZ Bank New Zealand has been in the country in one form or another since 1840. From those humble beginnings as a branch on the Petone foreshore to being one of New Zealand's largest companies with dominant market share in every major city and town in the country we've had to constantly evolve to meet the needs of our customers.

It's sometimes easy to overlook those changes; cheque accounts, ATMs, credit and debit cards, phone banking, internet banking and smartphone banking apps.

The next wave of innovation is around the digital age and ANZ is proud of the work it is doing in this space. We unashamedly say we want to be a world leading digital bank with a human touch.

We say that because customers tell us that's what they want. They want access to their money anywhere, anytime. But it is more than convenience, choice and connectivity. We know that if we can unshackle them from the constraints of traditional banking, being locked into a time and place for doing things, then people and businesses will thrive.

Artificial Intelligence technology is the next frontier. Its impact has been compared with the invention of electricity and according to the World Economic Forum, an important component of the Fourth Industrial Revolution.

DAVID HISCO
Group Executive and CEO New Zealand
ANZ

How we choose to utilize AI will impact how New Zealand progresses as a nation. This research, commissioned by the AI Forum of New Zealand, helps us all start this journey.

I invite you to start, as I have, by being curious about the factors that shape our world and to constantly look to innovate.

FOREWORD
Microsoft New Zealand

Artificial Intelligence is now an essential element in New Zealand's journey towards being a Digital Nation.

As one of the global leaders in developing AI, Microsoft has been thinking deeply about the social and economic implications of AI for some time. I'd like to share some of our insights and ideas that are relevant to this journey. They are drawn from our recent publication *The Future Computed: Artificial Intelligence and its role in society.*

First, we see that the countries that will fare best in the AI era will be those that embrace the changes that AI enables rapidly and effectively. AI will be useful wherever intelligence is useful, helping us to be more productive in nearly every field of human endeavour. New jobs and economic growth will accrue to those who embrace the technology, not those who resist it.

Second, while we believe that AI will help improve daily life and solve big societal problems, we can't afford to look to this future with uncritical eyes. There will be challenges as well as opportunities. We must address the need for strong ethical principles, the evolution of laws, the importance of training for new skills, and even labour market reforms. This must all come together if we're going to make the most of AI.

Third, the question of how we embrace AI can't be left to the tech sector alone. We have a shared responsibility to address both the opportunities and challenges we face together. This is far preferable to having only a few companies control the future of AI. As technology evolves so quickly, those of us who create AI, cloud and other innovations will know more than anyone else how these technologies work. But that doesn't mean that we will know how best to address the role they should play in society. This requires that people in Government, academia, business, civil society, and other interested stakeholders come together to help shape this future. Each of us has a responsibility to participate.

BARRIE SHEERS
Managing Director
Microsoft New Zealand

Microsoft

Microsoft New Zealand's mission is to play our part in enabling New Zealand's evolution as a digital nation. We are committed to helping ensure that technology contributes to a thriving economy, robust institutions, prosperous and healthy people, and strong communities. This is why we were quick to become a member of the Artificial Intelligence Forum of New Zealand.

As the saying goes, if you don't know where you are going, any road will do. New Zealand cannot afford such an approach. This report gives us all a map, a baseline of understanding and ideas that is essential to informing what we now do in the coming months and years. I commend it to you.

Executive Summary

Artificial Intelligence (AI) is emerging everywhere today: as a virtual assistant on every new smartphone, a robo-advisor to help make investment decisions, driving autonomous vehicles on our roads and in sophisticated algorithms underlying recommendation engines for many of the world's leading web platforms.

AI is perhaps the most talked about technology of our time, promising to transform fundamental aspects of how we live, work and play. The capability of AI to perform increasingly more tasks that were previously the sole preserve of humans will free people up to focus on higher value, more fulfilling activities. However, this also creates a sense of unease about our very usefulness in the future. Either way, intelligent systems will play an ever increasing role in determining New Zealand's future prosperity, security and social cohesion.

The term 'Artificial Intelligence' is notoriously hard to define, spanning a wide range of reference points from data science, machine learning and conversational interfaces right through to debate about whether AI will displace jobs and lead to science fiction scenarios.

For the purposes of this study, we define artificial intelligence as: ***advanced digital technologies that enable machines to reproduce or surpass abilities that would require intelligence if humans were to perform them.*** This includes technologies that enable machines to learn and adapt, to sense and interact, to reason and plan, to optimise procedures and parameters, to operate autonomously, to be creative and to extract knowledge from large amounts of data.

The impact of AI technologies will be more widespread than most people are aware today. Undoubtedly, AI will have major long term impacts on our business and economy, legal frameworks, ethics, environment, education, labour, productivity, social and justice outcomes. Perhaps unsurprisingly, given its complexity and rapid emergence, New Zealand's understanding of AI's significance is low compared to other issues with similarly wide-ranging effects on our society. This report advocates the need to act now, in a substantial, coordinated way, to increase New Zealand's ability to remain competitive and adapt to changes brought about by AI.

AI technologies have already reached a tipping point of maturity and readiness for adoption across a broad range of applications.

AI can be used to help us personally achieve more than we currently do, by augmenting our individual cognitive ability with new tools to increase our own productivity.

Implementation of AI technologies will also support new capabilities which were previously technically impossible or too expensive.

In our society and across Government, AI may be applied to supporting social outcomes such as informing future policies on taxation to improve the distribution of wealth. It can help achieve better environmental outcomes, for example accelerating efforts towards a pest free New Zealand, and helping predict the effects of climate change.

AI also raises significant ethical questions and challenges for our legal and political systems, which we are only just starting to address. Many of the challenges such as identifying biased data and ensuring proper accountability are well known to policymakers engaged in evidence based decision making. Other challenges are new, such as the risk of AI being used in cyber warfare and autonomous weapons.

In the economy, AI can be used to substitute human labour in a growing range of manual or repetitive tasks, enabling that same labour to be redeployed onto new, higher value tasks. Our modelling analysis finds that just through this labour conversion alone, AI has the potential to increase New Zealand GDP by up to $54 billion by 2035 across 18 industry classifications.

> ***"Just as 100 years ago electricity transformed industry after industry, AI will now do the same. Countries with more sensible AI policies will advance more rapidly, and those with poorly thought out policies will risk being left behind."***
>
> ANDREW NG, Stanford University / Coursera

AI may also have a rapid impact on work patterns and education choices, but in unexpected ways. AI is often feared to have a major negative impact on jobs, however in this study we assert that AI will not lead to mass unemployment. Widespread adoption of AI could take 20-40 years until it is expected to fully impact employment patterns. During that time natural changes in the labour market will be significantly larger than any expected impact from AI and existing labour market support policies should be able to cope. Some commentators argue that due to the speed and scale of labour market change expected, AI is different to previous technology cycles. Our research does not support this view.

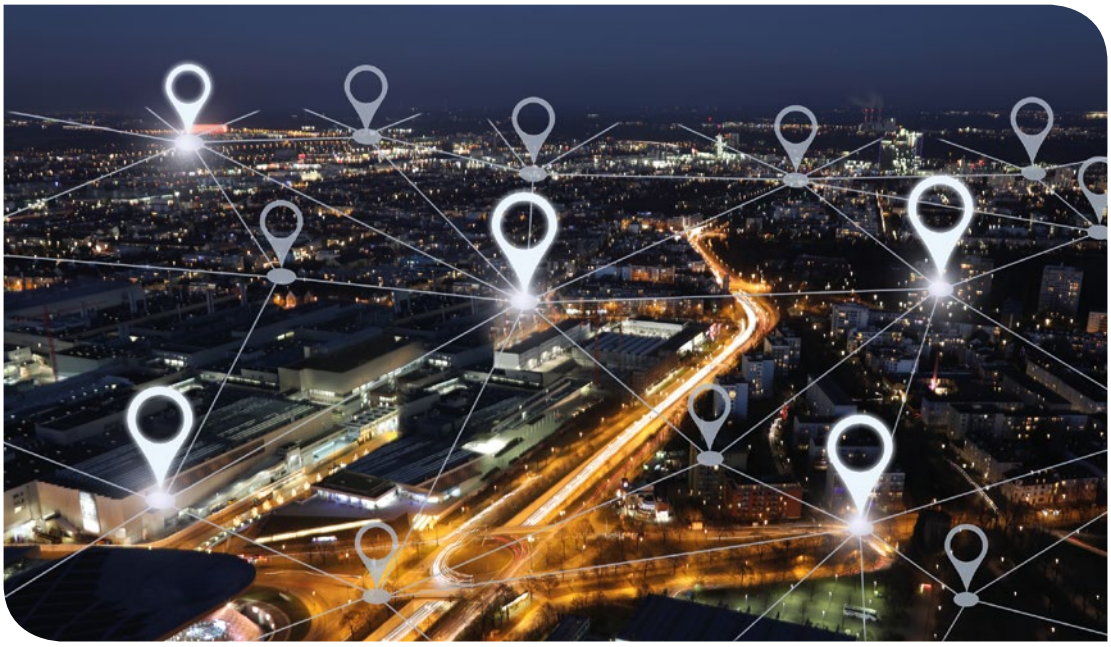
However, we anticipate significant impacts from technology related job losses for the individual workers affected. Government and industry must collaborate to maintain support structures for technologically displaced workers, accurately identify roles at risk of displacement and increase investment in the development of new skills as part of a long term human resource plan for New Zealand.

We are seeing encouraging signs of AI innovation across all sectors in New Zealand. Companies including Air New Zealand, Soul Machines, Xero and a range of startups are leading the development of AI nationally. New Zealand's leading universities have teams of AI experts publishing world class research and with promising potential for commercialisation success. The AI Forum has identified a young ecosystem with more than 140 organisations already working with, or investing in AI in New Zealand.

AI is a necessary component of economic competitiveness on the international stage, directly supporting future productivity as the quantity and value of data grows. Like most nations, New Zealand is a small player on the international technology stage and does not have the depth of capital resources to create platforms at global scale. Historically, we have thrived in technology niches driven by our inventive entrepreneurs. In a similar vein, New Zealand AI firms will be able to successfully build upon foundational platform technologies developed overseas and export AI enabled intellectual property into niche markets. Given the New Zealand Government intends to make ICT the second largest contributor to GDP by 2025[1], continued investment in AI will be a vital component of this success.

Equally important, New Zealand's traditional export earners including agriculture and tourism are starting to show early signs of vulnerability to overseas technology enabled competition and disruption. The challenge is that New Zealand organisations are not taking AI, or the competitive pressure that it will create, seriously. Throughout the research, participants were concerned that many businesses are simply being complacent about both the opportunities and the potential broader challenges of AI. There is concern that New Zealand's business and Government leaders lack skills and experience in these technologies which are so crucial for our economy's future.

Internationally, there is clear evidence of an emerging duopoly with the United States of America (US) and Chinese companies dominating AI investment. The Chinese Government has developed a national strategy which includes both commercial and military applications for AI and aims to make China the dominant global player with an AI sector worth US$150 billion by 2030. However, China's all encompassing approach to individual data privacy would not be acceptable in New Zealand.



[1] Media Release: New Chief Technology Officer role created. Minister Curran, New Zealand Government. December 2017.

Meanwhile, other countries around the world are also investing strategically in their AI capability. Nations such as Australia, Canada, Singapore, South Korea and United Kingdom (UK) are investing significantly across the AI value chain: from deep theoretical research to applications in healthcare, financial services and online consumer services. This report identifies the gap in strategic intent and coordination at a national level in New Zealand to invest in a focused development of AI capability. We need to decide now how we leverage our existing strengths of agility, trust and innovation to maximize New Zealand's opportunities and adapt to changes driven by a forthcoming wave of AI driven developments.

Developing the right AI skills and talent is one of the most important actions that New Zealand must undertake. For example, there is an acute worldwide shortage of machine learning experts and intense international competition for talent. How does New Zealand differentiate itself internationally to attract and develop a sustainable pipeline of world class talent?

Ultimately, this report concludes that New Zealand needs to engage substantially with AI now to shape a prosperous, inclusive and thriving future for our nation. New Zealand's AI journey is approaching a crossroad, where we either choose to proactively help shape its impact on our economy and society, or we passively let AI shape our future lives. To shape, or be shaped?

> *"The future [of AI] is going to be a battle for data and for talent"*
>
> **DAVID WIPF,** Lead researcher at Microsoft Research, Beijing

New Zealand needs to engage substantially with AI now to shape a prosperous, inclusive and thriving future for our nation.

Recommendations

The AI Forum and its research partners have developed a number of recommendations arising from this research project, distilled from interviews with over 40 people from the following sectors:

- Academia
- Private sector end user organisations
- Public sector end user organisations
- AI technology companies
- Law
- Consulting

The recommendations fall under six themes. For a detailed explanation of each, please refer to the recommendations in Part Four, pages 82 – 86.

THEME 1
Forging a Coordinated AI Strategy for New Zealand

Recommendations:

1.1 Develop a coordinated national AI strategy as part of New Zealand's wider Digital Strategy.

1.2 Ensure AI features strongly in the national cybersecurity strategy.

THEME 2
Creating Awareness and Discussion of AI

Recommendations:

2.1 Advance AI awareness and understanding.

THEME 3
Assisting AI Adoption

Recommendations:

3.1 Develop 'how to' best practice resources for industry and Government.

3.2 Accelerate Enterprise AI deployment.

3.3 Support SME adoption of AI.

3.4 Support AI startups and exporters.

THEME 4
Increasing Trusted Data Accessibility

Recommendations:

4.1 Increase data availability and accessibility.

THEME 5
Growing the AI Talent Pool

Recommendations:

5.1 Increase the supply of AI talent.

5.2 Encourage AI student diversity.

5.3 Teach AI in schools.

THEME 6
Adapting to AI effects on Law, Ethics and Society

Recommendations:

6.1 Establish an AI ethics and society working group.

6.2 Review employment practices, law and obligations.

6.3 Review high priority legal implications of AI.

Key Highlights

TOP 5 DRIVERS OF AI UPTAKE IN NEW ZEALAND

- **Make sense of vast amounts of data**
- **Automate tedious or dangerous work**
- **Support decision making with speed and accuracy**
- **Reduce business costs by automation**
- **Optimise business processes**

By 2035, **AI has the potential to increase New Zealand GDP** by up to

$54 billion

44%* **consider education as a key barrier** to AI adoption.

52%* **say that AI will be, or already is, a game changer** in their organisation.

Just ***36%**** **say their company's board is discussing AI.**

Over the next ***40*** years **AI-driven job displacement will account for only 10 per cent of normal job creation and destruction.**

AI frees people up to focus on more complex, higher-value tasks.

Canada, China, France, Singapore, South Korea, UAE and UK have all developed multi-million dollar **national AI investment strategies.**

New Zealand currently does not have a national AI strategy.

New Zealand ranked *9th* among 35 OECD countries for Government AI Readiness (2017).

Adoption of AI by New Zealand Government is **disconnected and sparsely deployed.**

AI raises many **new ethical concerns relating** to bias, transparency and accountability.

AI will have **long term implications for core legal principles** like legal responsibility, agency and causation.

There is an **acute worldwide shortage of machine learning experts** with competition for talent. Machine learning is the **highest demand growth** tech skillset globally.

*of survey respondents.

PART ONE:

The AI Landscape


2,1

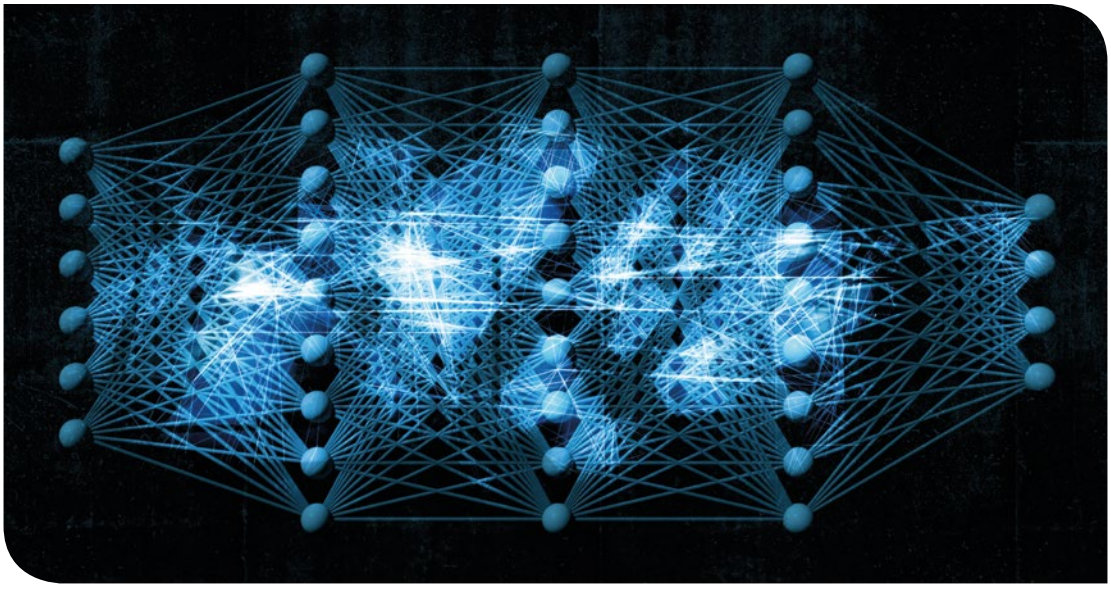
PART ONE: The AI Landscape

There is broad interest in artificial intelligence: its theories, its technology, its ability to solve business problems, its ethical ramifications and how it might be used to create a better society.

The pace of change in technology continues to increase and AI is emerging as a transformative set of tools and technologies to solve many business and social problems. During this research project we found that more than half of New Zealand organisations that we surveyed think AI will be, or is already, a game changer and will enable transformation of business and society.

The term "artificial intelligence" was originally coined in the 1950s – but it has taken until today for the enablers of AI to converge into a new global ecosystem. Cloud computing and data processing capability are becoming increasingly powerful and affordable. Organisations are placing greater value on opportunities arising from data. People are becoming more skilled in applying algorithms to solve problems with AI and open source tools and training are becoming more readily available online.

Artificial Intelligence:
Advanced digital technologies that enable machines to reproduce or surpass abilities that would require intelligence if humans were to perform them.



History of AI

1956

Scientist **John McCarthy** coined the term *"artificial intelligence"* for the Dartmouth conference.

1957

Frank Rosenblatt developed the Perceptron, software capable of pattern recognition.

1950

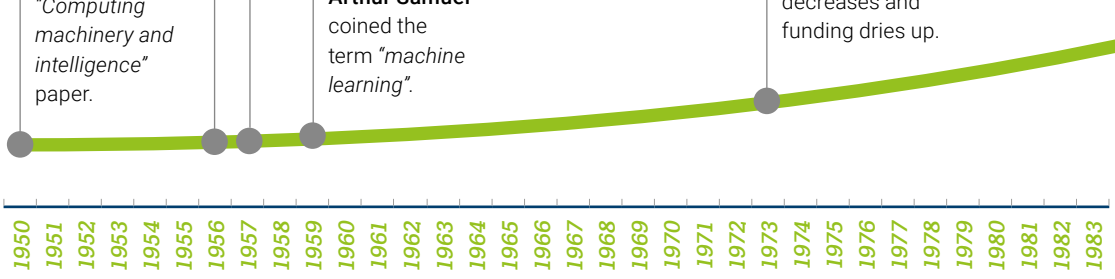
Alan Turing publishes *"Computing machinery and intelligence"* paper.

1959

Scientist **Arthur Samuel** coined the term *"machine learning"*.

1973

The first "AI winter" sets in as interest in AI decreases and funding dries up.



2011

Apple launches **Siri**, a voice operated personal assistant.

IBM's supercomputer **Watson** beats two human champions at TV quiz game Jeopardy.

2012

Google's driverless cars navigate autonomously through traffic.

2017

First AI citizenship granted to **Sophia** from Hanson Robotics in Saudi Arabia.

International Partnership on AI to benefit people and society established.

2018

Alibaba language processing AI outscores top humans at a Stanford University reading and comprehension test.

Microsoft publishes *"The Future Computed - Artificial Intelligence and its role in society"*.

1994

First web search engines launched.

1986

Bundeswehr University in Munich develops the first self-driving car.

1987

The second "AI winter" begins.

1997

IBM's Deep Blue beats world champion **Garry Kasparov** at chess.

1998

NASA's Remote Agent is first fully autonomous program to control a spacecraft in flight.

2002

Amazon replaces human product recommendation agents with an automated system.

AlphaGo

Deepmind's AlphaGo defeats Lee Sedol, one of the world's leading Go players.

2016

Google launches Translate, a machine translation service.

2007

1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018

What is Artificial Intelligence (AI)?

There is no single universally agreed definition for AI.

Definitions range from the technical to the philosophical and for many people, the lack of a simple definition can make AI difficult to understand.

From one perspective, definitions can focus on the technologies and techniques themselves. In this case, AI may be defined as using neural networks and other complex algorithms to enable machine learning, deep learning, real-time data analytics, natural language processing and machine vision. (Refer to the appendix for further information on these various AI technologies and techniques).

A more abstract approach yields scientist Max Tegmark's definition, "non-biological intelligence with the ability to achieve complex goals."[2] A recent study into growing the AI industry in the UK[3], describes AI as "a set of advanced general purpose digital technologies that enable machines to do highly complex tasks effectively."

AI is becoming more common in online applications, often without being called AI. Once something becomes commonplace and useful enough it's often not labelled AI anymore. For example, Google Maps, which uses machine learning to read street signs and provide people with better directions[4].

For the purposes of this study, the AI Forum defines artificial intelligence as: ***advanced digital technologies that enable machines to reproduce or surpass abilities that would require intelligence if humans were to perform them.*** This includes technologies that enable machines to learn and adapt, to sense and interact, to reason, predict and plan, to optimise procedures and parameters, to operate autonomously, to be creative, and to extract knowledge from large amounts of data.

It is also important to distinguish between *Narrow* and *General* AI. Narrow AI performs a specific task, for example, playing a game (like Go or Chess), engaging with customers to provide customer service responses or analysing MRI scans to support a doctor's diagnosis. All current working examples today are considered Narrow AI.

General AI is the (as yet theoretical) scenario where a machine could successfully perform any intellectual task as well as, or better than, a human. There is much debate as to when, if ever, human level General AI may be achieved. In this report, we focus on Narrow AI applications, unless specified.

What can AI do?

Artificial Intelligence can:

- **improve productivity or efficiency.** AI can often complete routine tasks faster, better or with more consistency than a human can. For example, selecting goods from a warehouse and filling orders or driving a vehicle.
- **make sense of huge amounts of data.** We live in a data rich world and human brains are not equipped to analyse today's vast quantities of structured and unstructured data, make connections, identify relationships and patterns across datasets. AI can and does this well. For example, analysing MRI scans to identify tumours or monitoring switches in a factory to predict maintenance needs.
- **improve decision making.** AI can use data as an input to make fact based decisions that reduce bias, take proper account and weigh all the facts. For example, reviewing patient records to provide support for a clinician's decision or financial transactions to support financial advice.

[2] Machines taking control doesn't have to be a bad thing. The Guardian, 16 September 2017.
[3] Growing the Artificial Intelligence Industry in the UK. UK Government, October 2017.
[4] Updating Google Maps with Deep Learning and Street View. Google Research Blog, May 2017.

- **improve customer experiences.** AI driven conversational interfaces (also commonly known as chatbots), can provide faster, more accurate customer service in many languages. AI can also personalise experiences and services, delivering a customised service, for each individual, for example personalised learning.
- **enable human-like vision.** AI enables computer systems to see, process and understand visual images such as photos and videos. For example, using computer vision for facial recognition or to identify objects in photos of eyes improving the detection of eye disease that can potentially lead to blindness[5].
- **augment human intelligence.** While the human brain is undeniably incredible, there is only so much it can achieve in 24 hours. AI can radically enhance the intelligence of people, for example, by curating content, using contextual text analysis and extracting the meaning from data using machine learning.

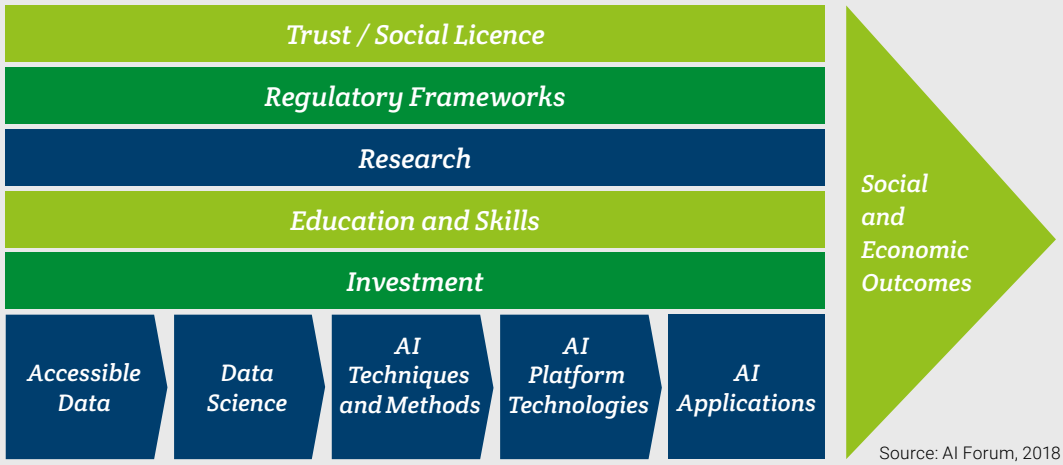
Leading computer scientist and AI expert Andrew Ng believes that if a typical person can achieve a mental task with less than one second of thought, we can probably automate it using AI, either now or in the near future[6].

Subsequently, AI will enable organisations to complete some complex tasks at scale, at a fraction of the cost of human labour and often with superior results. AI will also supplement and amplify human capability so that people and organisations can achieve even more.

The AI Value Chain

The AI value chain, as shown in Figure 2, illustrates AI technologies building upon the ready availability of comprehensive, accessible data and core data science techniques to deliver the higher level social and economic outcomes covered in this report. This is supported by social licence, regulation, research, education, skills and investment. Investment will be required, in each of these areas, for New Zealand to maximise beneficial economic and social outcomes.

Figure 2 – Artificial Intelligence Value Chain



Source: AI Forum, 2018

[5] Deep Learning for Detection of Diabetic Eye Disease. Google Research Blog, November 2016.

[6] What Artificial Intelligence Can and Can't Do Right Now. Harvard Business Review, November 2016.

National AI Strategies Around the World

Artificial Intelligence is evolving at a rapid pace and several developed countries have coordinated plans, policies or initiatives underway to address the opportunities and challenges.

Many countries have recently produced reports on AI, which often leads to focused Government and private sector investment. The following section captures a range of national AI initiatives from around the world.

Australia

Australia has a history of investing in AI research and development. In 1988, the Government established the Australian Artificial Intelligence Institute, which by 1996, had over 40 staff. Its clients included Daimler-Benz, Optus Communications and the Australian Department of Defence. The institute researched and commercialised agent-oriented-software or what we refer to today as 'bots'. This includes chatbots and other software bots that perform automated tasks over the internet.

In September 2017, the Australian National University announced a ten year investment in AI capability, launching the Autonomy, Agency and Assurance Institute. Leading the institute is anthropologist Genevieve Bell, previously a vice president of Intel. The institute's focus is understanding the implications that AI will have on society. Risk, indemnity, privacy and trust will be key areas of research.

Also in 2017, the Australian CSIRO (Commonwealth Scientific and Industrial Research Organisation) commissioned Dell EMC to build an AU$4 million deep-learning supercomputer called Bracewell. The supercomputer is powerful; at 1 petaflop it can perform one thousand trillion operations per second. Bracewell enables the Australian AI research teams to scale their research and to use large training data sets.

Artificial Intelligence Around the World

Canada

Canada is becoming a major player in the AI revolution having produced several world leading experts including Geoffrey Hinton of the University of Toronto (and now Google) and Yoshua Bengio of McGill University, Montreal.

The Canadian Government continues to show interest and willingness in AI, with CA$125 million in its 2017 budget for artificial intelligence[7]. The Government formed the Vector Institute in 2017, which aims to develop and sustain AI innovation, growth and productivity. The organisation will also increase awareness and knowledge of the value AI can create in the private sector.

In 2017, prominent private organisations have also announced or established AI research bases in Canada:

- French engineering group Thales SA has announced the launch of an AI hub in Montreal, focussing on the aerospace industry, as well as rail and armed forces. Thales SA chose Canada because its universities are producing top talent in the AI space.
- Google is establishing an AI team based at Canada's University of Alberta.
- Microsoft has established an AI research and development organisations in Montreal.
- Uber, Facebook and Samsung have also all launched research labs in Canada.

China

In mid-2017 China issued its Next Generation Artificial Intelligence Development Plan[8]. The plan says AI's rapid development will profoundly change the world with AI a 'new focus of international competition' and a 'new engine of economic development.' Subsequently, the Government wishes to build China's first-mover advantage in AI development. The Government also noted that great importance should be placed on challenges around employment, personal privacy, international relations and in ensuring the 'safe, reliable and controllable' development of AI. Its ideology is focused around using AI for economic development, societal improvements and for national defence. Their basic principles include AI be technology led, with a targeted system development strategy, to speed up commercialisation of products and to advocate open source sharing.

China's strategic objectives include:

- overall AI technology to be on pace with globally advanced levels by 2020.
- achieving major breakthroughs in basic theories of AI by 2025 to enable development of world leading technology and applications.
- to become the world's primary AI innovation centre through the maturity of its AI research and technologies, its industry competitiveness and visible results, by 2030.

China's key advantage is certainly its scale. Substantial research labs will develop talent and the country's size means infrastructure, such as computing power, is already in place. Its large population will also prove useful in generating the massive amounts of data AI needs to be able to learn.

Web services company Baidu has a division dedicated to AI research and is building, in partnership with the Government, China's first national AI research lab centre. Research in progress includes an operating system for driverless cars and Chinese language virtual personal assistants.

Estonia

Estonia, well known for its digital transformation, including the introduction of a national digital ID for citizens, e-residency and online voting has begun to focus on AI. As part of the e-Estonia Digital Society Project the Estonian Government is considering opportunities for implementing AI based solutions as a further upgrade to the already advanced level of the citizen services provided by private and public organisations.[9]

During the summer of 2017 driverless buses were able to operate on small routes through the capital city. This sparked discussions about the feasibility and legal

[7] Growing Canada's Advantage in Artificial Intelligence, Budget 2017. Department of Finance, Canada, March 2017.
[8] A Next Generation Artificial Intelligence Development Plan. China State Council, July 2017.
[9] Artificial Intelligence is the next step for e-governance in Estonia. e-Estonia.com, September 2017.

frameworks that will be required for the application of AI technologies to everyday tasks of Estonian citizens. The Government has publicly acknowledged its intention to be a trailblazer in AI regulation and legislation by considering giving robots legal recognition. This would classify 'robot agents' in a position between being a legal entity and being owned property.

European Union (EU)

The draft report on the civil law rules for robotics[10] prepared for the EU Committee on Legal Affairs received media attention based on two specific recommendations:

- to establish robots as electronic persons.
- to make their owners pay tax.

However, the draft report also proposed much broader recommendations about robotics and AI, and the ethical and societal issues that may arise from these technologies. Due to employment, human safety, liability and privacy risks, the issues must be tackled with urgency say the report authors.

The report also called for legislation to consider all implications of robotics and AI including definitions of autonomous robots, a registration system and resources for research and innovation. The report also made recommendations for testing robots in real life scenarios, autonomous car regulations, care robots, appropriate training for working with medical robots, human enhancement, and drones.

The authors stressed the need for a guiding ethical framework based on human rights and the creation of a European agency for robotics and AI. It noted there are no current legal provisions that apply specifically to robots and intellectual property rights, and there needs to be privacy and data protection guarantees, particularly relating to personal data as a currency.

In February 2017, the Committee on Legal Affairs voted on the draft plan. Universal Income and the potential for taxes on robots were not voted for inclusion in the final report, as there were concerns these recommendations stifle innovation. Instead, the committee focused on the proposed ethical standards, an insurance scheme for liability and regulations for driverless cars. These proposals are currently moving through the executive branch of the EU.

The German Government released a code of ethics[11] for autonomous vehicles in August 2017. The Government will adopt new guidelines for self-driving cars in Germany, prioritising the value and equality of human life, over damage to property or animals.

France

At the time of completing this report, French President Emmanuel Macron launched France's new national AI strategy[11a]. The Euro €1.5 billion investment over the next four years will focus on talent returning to work in France and developing sector-specific AI technology in areas where the state has large data stores.

Singapore

In 2017, the Minister for Communications and Information announced that Singapore's National Research Foundation will invest up to SG$150 million over five years into AI Singapore, the nation's artificial intelligence programme. The programme assembles Singapore's research organisations and companies to develop knowledge, talent and tools to encourage AI uptake.

AI Singapore's objective is to address large societal and industrial challenges such as traffic congestion and healthcare issues. The programme will invest in AI capabilities and work with the private sector to use AI to increase productivity, develop and commercialise new products and services. The Government believes the greatest potential in the private market is within the finance, healthcare and city management sectors.

[10] Civil Law Rules for Robotics Draft Report, Commission on Civil Law Rules on Robotics, Committee on Legal Affairs. European Union, May 2016.

[11] Automated and Networked Driving. Report of the Ethics Committee, Federal Ministry for Traffic and Digital Infrastructure, German Government, August 2017.

[11a] https://www.aiforhumanity.fr/pdfs/MissionVillani_Report_ENG-VF.pdf

South Korea

The dramatic defeat of top Korean Go player Se-Dol Lee by Google DeepMind's AlphaGo was the catalyst for the Government to invest KRW₩1 trillion (NZD$1.2 billion) in AI research over the next five years. The combination of the South Korean Government investment injection and the private sector's innovation of new products and services using cognitive systems is creating a synergy that is elevating South Korea's presence on a global level.

South Korea's Artificial Intelligence Research Institute released a report on AI in South Korea as a policy issue in September 2017. The report detailed the need for an AI strategy because other major countries were already paying attention to AI's influence and establishing counter measures. It recommended that South Korea focus on training AI and computing experts.

The report also recommended that South Korean policy needs to promote a 'fair and dynamic' society that encourages training people to be creative and innovative. The report condemned employment rigidity in current policy which hinders competition and could cause issues with changes in labour types due to AI.

The report also recommended sharing and participation to democratise technology and turn it into a social asset. In summary, the report called for AI to become better understood by Government and that social change through technology needs to be well managed. It warned that the law and its institutions may need to undergo substantial change.

United Arab Emirates (UAE)

The UAE hit the news headlines in October 2017 with the appointment of the world's first Minister for Artificial Intelligence, with its desire to become 'the world's most prepared country for AI'.

The UAE's Strategy for Artificial Intelligence[12] claims to be the first of its kind and aims to:

- boost Government performance at all levels.
- use an integrated smart digital system that can overcome challenges and provide quick, efficient solutions.
- make the UAE the first in the field of AI investments in various sectors.
- create a new vital market with high economic value.

[12] UAE Strategy for Artificial Intelligence. Government of the United Arab Emirates, October 2017.

The strategy identifies nine key sectors to be covered: transport, health, space, renewable energy, water, technology, education, environment and traffic. In addition, it aims to use AI to save 50% of annual transaction costs in Federal Government. At the time of writing, further strategy implementation details were pending.

United Kingdom (UK)

In 2015, the UK Science and Technology Committee of the House of Commons produced a report on robotics and artificial intelligence[13]. The report made several recommendations for education, skills, governance, research and funding for robotics and artificial intelligence. Conclusions and recommendations include:

- ensuring a readiness to upskill and reskill citizens, on a continuing basis.
- the scrutiny of the ethical, legal and societal dimensions of artificially intelligent systems begins now.
- the development of a Government body for robotics and artificial intelligence.

In early 2017, British Prime Minister Theresa May launched Britain's 'Modern Industrial Strategy'. One of its ten strategic pillars includes investments in science, research and innovation which will include AI and robotics. In November 2017, the House of Commons announced an inquiry into the use of algorithms in public and business decision making.

"Algorithms have been in use for hundreds of years, but the sheer speed of computing power today makes many new applications possible. This poses important questions about how best to use these in making decisions that affect people, and also how to provide the right safeguards and oversight," said Stephen Metcalfe MP, Chair of the Science and Technology Committee, ahead of the inquiry.

As at October 2017, the committee was accepting written submissions around the extent of current and future algorithm use, 'good practice' in algorithmic decision making and methods for providing regulatory oversight of algorithmic decision making.

The Government also released the report, Growing the Artificial Intelligence Industry in the UK[14] which included the following recommendations:

- improve access to data by creating data trusts (frameworks and agreements to ensure data exchange is secure and mutually beneficial).
- Government sponsorship of AI masters degrees and PhD places to improve the supply of skills.
- develop practical guidance for the private sector on the opportunities and challenges of AI adoption across the UK economy.

United States of America (USA)

In recent years, USA tech giants Alphabet (Google), Amazon, Apple, Facebook, IBM and Microsoft have led the world in private sector AI investment. However, as noted earlier, Chinese investment in AI is rapidly accelerating and may challenge US leadership in the near future.

[13] Robotics and Artificial Intelligence Report, House of Commons Science & Technology Committee. UK Parliament, September 2016.
[14] Growing the artificial intelligence industry in the UK, Professor Hall & J. Pesenti. UK Government, October 2017.

In October 2016, President Obama's Executive Office published a report that laid out its plans for the future of AI[15]. They recognised the tremendous economic potential of AI and concluded that AI isn't a science project, it is commercially important.

"The biggest worry I have about AI is that we will not have enough of it, and that we need to do more…" wrote the Chair of President Obama's Council of Economic Advisers, Jason Furman in a separate report[16] .

"The analogy we still use when it comes to a great technology achievement, even 50 years later, is a moonshot. And somebody reminded me that the space program was half a percent of GDP. That doesn't sound like a lot, but in today's dollars that would be $80 billion that we should be spending annually… on AI," said President Obama.[17]

The Obama administration identified that the USA will need to expand its AI workforce and that China was also a world leader in AI. However, no strategies or plans have been presented on how to deal with these two potential issues.

A further report was released by the White House National Science and Technology Council presenting a national strategy for AI Research and Development (R&D)[18] with seven strategies and two recommendations. The report identified the priorities for federally funded AI research including human-AI collaboration; ethical, legal, and societal implications of AI; safety and security of AI systems; and shared public datasets and environments for AI training and testing. The main recommendation was to create and sustain a healthy AI R&D workforce.

However, a year later, with a new government in place, it appears that AI has a lower priority. Changes in tax and immigration policy are decreasing the number of AI researchers in the USA. Rather than increasing AI R&D funding in line with the recommendations from the Obama administration, the Trump administration is reducing AI research at the National Science Foundation by 10%, to just $175 million. As a result, in the USA, significant changes driven by AI will not occur for another 50-100 years says Treasury Secretary Steven Mnuchin, who also recently replied in an interview, that 'it's not even on my radar screen.'

While the White House may no longer be prioritising AI, other branches of Government continue to push forward. Senator Maria Cantwell is working to propose a federal advisory committee on AI for the United States Senate, and the Congress and the Department of Transportation are picking up the pace on driverless cars and drones. However, federal agencies, states and courts are approaching AI in an ad hoc way with no clear national strategy.

In March 2018, the Center for Strategic and International Studies, a bipartisan think tank, published a study urging the Government to develop a national strategy for machine intelligence[19]. It recommended the White House urgently implement the 2016 AI R&D Strategy recommended by the National Science and Technology Council and noted that most significant nations already have national AI strategies.

[15] Preparing for the Future of Artificial Intelligence. National Science and Technology Council Committee on Technology, Executive Office of the President, October 2016.

[16] Is This Time Different? The Opportunities and Challenges of Artificial Intelligence. Furman J, Chairman, Council of Economic Advisers. July 2016.

[17] Barack Obama, Neural Nets, Self-Driving Cars and the Future of the World. WIRED, August 2016.

[18] The National Artificial Intelligence Research and Development Strategic Plan. National Science and Technology Council Committee on Technology, Executive Office of the President, October 2016.

[19] A National Machine Intelligence Strategy for the United States. Center for Strategic and International Studies, March 2018.

The New Zealand AI Landscape

At the outset of this research, it was unclear how many organisations are using AI or what the general sentiment about AI is, as a nation. New Zealand currently does not have nationally coordinated AI policy or a strategy.

The AI Forum set out to develop insights into the current New Zealand AI landscape, to inform analysis of opportunities and challenges and to support policy development.

Through initial market discussions it became apparent that very few people or organisations are considering AI, or its potential implications. With little understanding of AI in the broader market the research focused on identifying who is currently engaged in AI, either commercially or academically. Research was conducted via interviews with individuals and organisations throughout New Zealand. These interviews were complemented by a survey of technology businesses and other significant users of technology. The aim of this part of the study was to develop an understanding of the knowledge, perceptions and attitudes toward artificial intelligence across New Zealand. (Please refer to the appendix for our research methodology.)

New Zealand Organisations are Adopting AI

There are a growing number of AI solutions being deployed or already deployed across the New Zealand economy including in the agriculture, energy, financial services, retail and transport sectors.

Over 20% of the organisations surveyed have already adopted some form of AI system. However, this result may not be truly representative of the economy as a whole, as survey respondents were primarily large enterprises that already have significant investments in information technology. Nearly half of the respondents were in the information media or telecommunications industries.

These companies however, are the early adopters of AI in New Zealand, with 52% saying that AI will be, or already is, a game changer in their organisation. The most popular implementations of AI currently are:

LEGAL AI FOR MERGERS AND ACQUISITIONS

Chapman Tripp, one of New Zealand's leading commercial firms is bringing innovation to the legal sector with Zeren, its technology business. *In November 2017, the firm selected AI platform, Luminance, to assist with due diligence for both domestic and international mergers and acquisition (M&A) transactions.*

Luminance utilises pattern recognition and machine learning technology to create an efficient and faster contract review process. It does this by organising data into an intuitive visualisation dashboard, enabling lawyers to quickly gather insights to assist their review. The software can also identify anomalies between contracts to ensure the M&A team are aware of any subtle differences at the start of the review process.

Implementing this AI technology provides a faster review process without sacrificing accuracy, but also simplifies the project management aspects of large scale M&A transactions.

- **Improving business processes.** Machine learning algorithms used to build new and better business processes.
- **Augmentation of current applications.** Leveraging machine learning cloud services such as facial recognition to augment current applications.
- **Process automation.** Robotic Process Automation (RPA) software to handle transactional processes such as payments and billing.
- **Cybersecurity.** Automated threat intelligence and prevention systems.
- **Customer service.** Automated conversational interfaces ("chat bots") and "digital employees" to automate customer service scenarios.

Narrow Application Focus Expected to Continue

According to international research, narrow AI applications, which are used to solve specific problems, will dominate AI uses in the next 10 years, accounting for 99.5% of AI spend[20]. The narrow application of AI is also apparent in New Zealand, with 68% of respondents considering AI to improve customer relationship management and 61% planning to deploy intelligent assistants, or chatbots, to support enquiries. The next highest planned use of AI is for the deployment of embedded intelligence into business processes, with 62% planning to deploy AI to support financial analytics and management reporting.

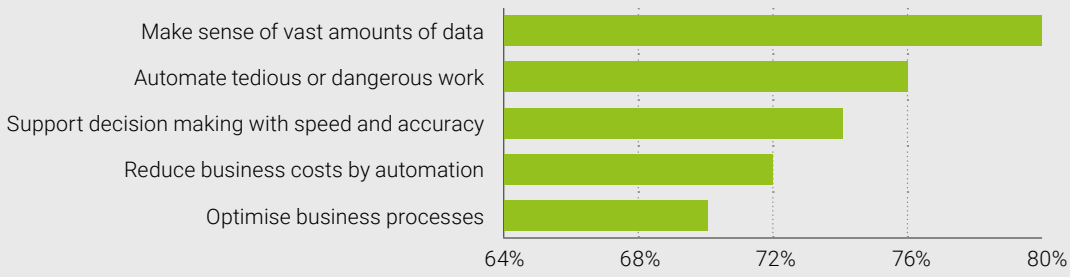
> *"The companies and countries that will fare best in the AI era will be those that **embrace these changes rapidly and effectively.** The reason is straightforward: AI will be useful wherever intelligence is useful."*
>
> **THE FUTURE COMPUTED**, Microsoft, 2018

While these early adopters of AI are mainly deploying the technology to support horizontally aligned business processes such as finance or sales, we do expect to see the number of vertically aligned, or industry specific, AI solutions to broaden over time. Across the economy there are already a broad range of AI applications being deployed, as can be seen in the many case studies online at **www.aiforum.org.nz**

What will Drive AI Uptake in New Zealand?

Competitive pressure is the key driver for businesses to adopt AI. This competitive pressure leads to a subset of five main drivers for AI adoption as shown in Figure 3. The dominant driver being an attempt to make sense of the vast amounts of data being generated. This is becoming increasingly important as organisations create more data, share more data, and value data more.

Figure 3 – Top 5 Drivers of AI Adoption in New Zealand



Source: AI Forum National AI Survey, 2018

[20] Artificial Intelligence: 10 Trends to Watch in 2017 and Beyond. Tractica, December 2016.

While health and safety legislation is driving some to adopt AI in attempts to automate tedious or dangerous work, the majority of adoption is focused on managing data and information, to improve business performance.

"When you think about the way that knowledge is increasing at an exponential rate, human beings will need these tools (AI). We can't crunch this amount of data anymore without some assistance," says Amy Fletcher, Associate Professor, University of Canterbury.

However, for AI the quantity of data is less important than its quality, with recent research finding that many machine learning algorithms only require small good quality datasets.[21]

In public sector organisations, key drivers are also focused on making better use of large amounts of data. Future adoption is expected to be driven by increasing demands by citizens for improved public services such as healthcare and education.

A Broader Understanding of AI is Needed

Even within the early adopters of AI, the understanding of, or discussion about AI primarily sits within a small group of specialised technology staff. Only 36% of respondents indicated that discussions about AI are occuring at board level. This suggests a disconnection between the organisation and the board of directors with respect to an understanding of the opportunities and potential challenges presented by AI.

Organisations that have deployed AI tend to have more engagement from their board, however this still sits at only 58%. In organisations considering AI, only 28% are having board level discussion. Likewise, senior executive discussions about AI in firms that have deployed AI is high (91%) versus only 46% in firms still considering AI.

Bearing in mind that these firms are early adopters of the technology, we can extrapolate that discussions about AI in most firms and industries in New Zealand will be negligible beyond specialist technology staff.

Throughout the research, participants were concerned that many businesses are simply being complacent about both the opportunities and the potential broader challenges of AI. Knowledge, awareness and discussion at the technology specialist level needs to be translated upwards to board and executive level.

VOICE RECOGNITION IMPROVES CUSTOMER SERVICE

In 2017, ANZ Bank partnered with Nuance, a speech software company to launch AI driven voice biometrics.

The system identifies a person by using the characteristics of their speech and is designed to improve security on mobile devices for higher value transactions. Voice biometrics allow ANZ customers to use their voice to automatically authorise payments of more than $1000 through the bank's mobile apps.

The addition of voice identification technology simplifies the payment process at ANZ, allowing customers to omit the usual security measures when making payments, by using their voice. Although this change makes transactions faster, security is not compromised. This is because a person's voice has five to 10 times as many security points than other methods such as fingerprints.

"Our customers expect digital options for their banking and for it to be seamless and easy. A key challenge for banking today is to help customers do what they want to do safely and securely" says Craig Bunyan, ANZ General Manager, Technology

[21] Minimalist Machine Learning Algorithms Analyze Images From Very Little Data. Berkeley Lab, December 2017.

AI Research in New Zealand

Research into AI is occurring across all universities in New Zealand. The bulk of the research underway is originating from the various computer sciences departments, however AI research is crossing into multiple different faculties.

In 2017, there were 2,166 postgraduate students in computer science and IT at Honours level or higher in all of New Zealand's Universities, and 1,405 at Masters or PhD level. Total enrolments in this sector will increase through the ICT Graduate Schools hosted by the University of Auckland with The University of Waikato, Victoria University of Wellington with Weltec and Whitireia Polytechnic, and the Southern Tertiary Alliance[22].

EMOTIONALLY INTELLIGENT DIGITAL HUMANS

Soul Machines is an Auckland based company that aims to put a face to AI by creating emotionally intelligent Digital Humans. *Soul Machines was formed in 2016 after successful commercialisation by Uniservices of University of Auckland research led by founder Dr Mark Sagar. In November 2017, it announced a partnership with Autodesk, a US software company. The goal of this partnership is to create a digital human of Autodesk's Virtual Agent, Ava. This virtual agent will assist customers through the transaction process in an emotionally responsive manner.*

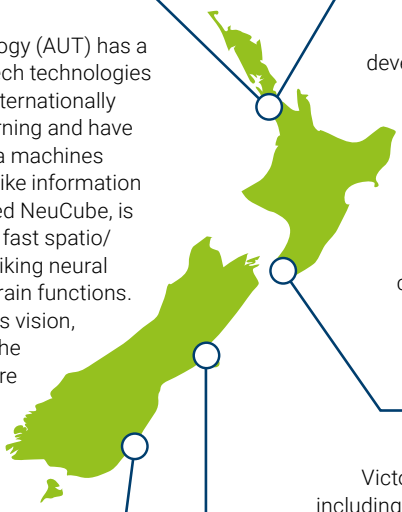
Utilising Soul Machines Human Computing Engine (HCE) consisting of neural networks and biologically inspired human brain models, Ava will be a human like virtual customer service agent. She will help customers solve problems by answering queries, directing them to the correct information and assist with transactions. The differentiating factor between Ava and other virtual assistants is that Ava will be capable of hearing, seeing and able to respond emotionally, just like a human being.

Soul Machines has gone on to develop digital employees for other leading global organisations such as Daimler Financial Services and Natwest Bank.

[22] AUT analysis, based on TEC enrolment data, 2018.

AUT

Auckland University of Technology (AUT) has a strong focus on language, speech technologies and mind theory. AUT has an internationally respected team in machine learning and have developed spatio-temporal data machines based on neuromorphic, brain-like information processing[23]. This system, called NeuCube, is designed to deal with large and fast spatio/spectro temporal data using spiking neural networks similar to the way a brain functions. AUT is also researching robotics vision, unmanned aerial vehicles and the monitoring of bees. AUT's Centre for Social Data Analytics is using predictive analytics to inform US Government Social Services interventions with families at risk.



THE UNIVERSITY OF AUCKLAND
Te Whare Wānanga o Tāmaki Makaurau
NEW ZEALAND

The University of Auckland has been working on developing life-like artificial systems. Its highest profile AI success to date is the development and commercialisation of spinoff AI company Soul Machines, based upon researcher Mark Sagar's groundbreaking work creating a virtual digital model human, BabyX. The company develops avatars that are a user interface for artificial intelligence platforms. Research is also underway in game AI, applied AI case based reasoning, multi-agent systems and data stream mining to name a few.

TE WHARE WĀNANGA O TE ŪPOKO O TE IKA A MĀUI
VICTORIA
UNIVERSITY OF WELLINGTON

Victoria University of Wellington has an AI team including staff across the Engineering, Mathematics and Computer Science faculties. The group conducts research in machine learning, neural networks, cognitive science and data mining led by Professor Mengjie Zhang. Professor Zhang's research centres on developing Evolutionary Computation (EC) and machine learning methods to solve real world problems in the areas of engineering, manufacturing and biology. His work includes developing new algorithms for data mining and optimisation tasks, developing computer vision applications for edge detection, segmentation and object recognition, and developing algorithms to create more effective production scheduling and personnel rostering.

UNIVERSITY OF OTAGO
Te Whare Wānanga o Otāgo
NEW ZEALAND

The University of Otago is investigating the potential impacts of AI in law and society in a project funded by the New Zealand Law Foundation. The Pattern Recognition and Machine Learning Lab are applying machine learning to environmental sensing, event detection and wireless sensor networking. The AI and Neural Networks lab focuses on computer vision, and models of human memory and language.

UC UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

In the South Island, the University of Canterbury's AI research centres on machine learning and algorithm engineering. A team led by Professor Simon Brown is developing neuromorphic computing technologies; essentially a computer chip that thinks like a brain. Canterbury's Professor Richard Jones has led advanced work in application and optimization of AI and machine learning technology to leading real-time passive brain-computer interfaces, particularly for detection/prediction of microsleeps and attention lapses from electroencephalogram (EEG). Canterbury also has significant crossover into the humanities, researching AI technology's wider impact on society, policy and law.

[23] Evolving spatio-temporal data machines based on the NeuCube neuromorphic framework. Kasabov N. et al, June 2016.

While Universities have been conducting research projects on AI in New Zealand and overseas for decades, it is only now rapidly becoming an attractive commercial opportunity. The momentum in the private sector has also exposed a disconnection between universities and businesses. The private sector needs research that is practical, applied and will develop solutions for real world business problems. Meanwhile, a significant part of university effort is still focused on pure, theoretical, AI research. Application expertise and frameworks are often lacking to produce outcomes that meet private sector needs and may also have extended time frames for successful commercialisation. There are several current university AI related projects linked to industry and a small number have led to commercial spin offs, such as The University of Auckland's Soul Machines and the evolution of Nyriad from its beginnings in data compression technology.

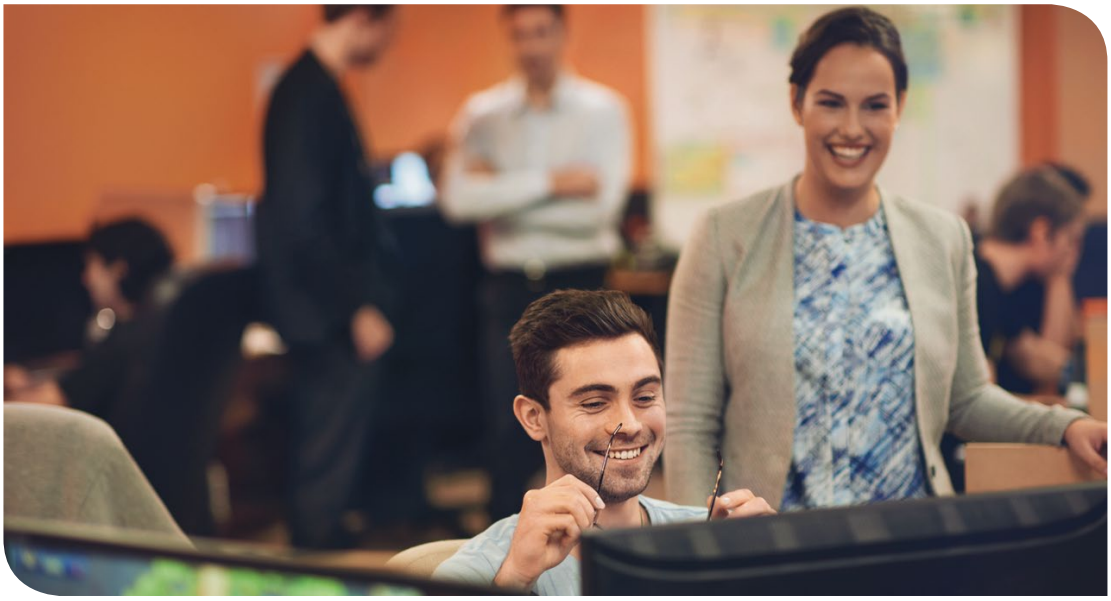
Another issue is how best to target academic AI research funding. Global technology giants are increasingly accelerating AI R&D to market, in the form of readily available, commoditised cloud services (APIs). There is a significant risk that by the time New Zealand universities approach the commercialisation of their academic AI research, equivalent services will already have been available for some time in public clouds, on demand and at low cost.

According to our respondents' feedback, to ensure academic research is better aligned and integrated with the private sector, several issues need to be addressed:

- a shortage of experienced AI researchers in New Zealand,
- a need for more applied research in AI, alongside ongoing pure research,
- better national coordination needed and
- increased investment in AI R&D.

A Shortage of AI Researchers

In order to accelerate both AI research and more effective use of AI within businesses, New Zealand needs to increase its onshore talent pool. Recent international research[24] has estimated there are



[24] Global AI Talent Report 2018. J-F Gagne, February 2018.

approximately 22,000 PhD qualified AI experts worldwide, of which only 85 are in New Zealand. Although a PhD is not technically required to be considered an AI expert, PhD level attainment is a useful proxy for assessing the technical ability of talent pools across different nations.

In addition, to sustain a good AI school or lab, skilled professors with at least five to ten years of direct experience are required. At the same time, the industry needs applied engineering and research, especially since needs will become increasingly specialized as the technology evolves.

In 2016, the New Zealand Government introduced a scheme, with a $35 million investment,[25] to attract world leading entrepreneurial researchers and their teams to New Zealand to help strengthen the country's universities and innovation ecosystem. There is a need to undertake a similar strategy to attract leading AI researchers. While this will be challenging, due to growing global demand for AI talent, it is essential that New Zealand actively competes for talent or risks becoming merely a downstream consumer of AI research from other countries. To put this challenge into context, Microsoft's recently established AI and Data R&D division has approximately five thousand employees.[26] This is just one of several international R&D divisions that are operating at this scale.

Better National Coordination Required

Geographically, New Zealand is a small country with limited resources and should consider a coordinated national approach to AI research.

Our research participants pointed towards the Canadian AI Strategy as a model to emulate. The Canadian Government has created the Pan-Canadian Artificial Intelligence Strategy which will provide CAD$125 million funding for AI research. The funding will build on research already conducted through the Canadian Institute for Advanced Research (CIFAR) and will help grow the talent pool required for Canadian businesses to succeed in the AI market.

Increased Investment in AI R&D Needed

In New Zealand, there is the opportunity to consider the realignment of existing funds and investment of new funds within a centrally coordinated framework to encourage open, collaborative AI research. This could be considered as part of a broader data science and technologies investment strategy. A central strategy combined with coordinated national collaboration should result in more effective and efficient use of research resources.

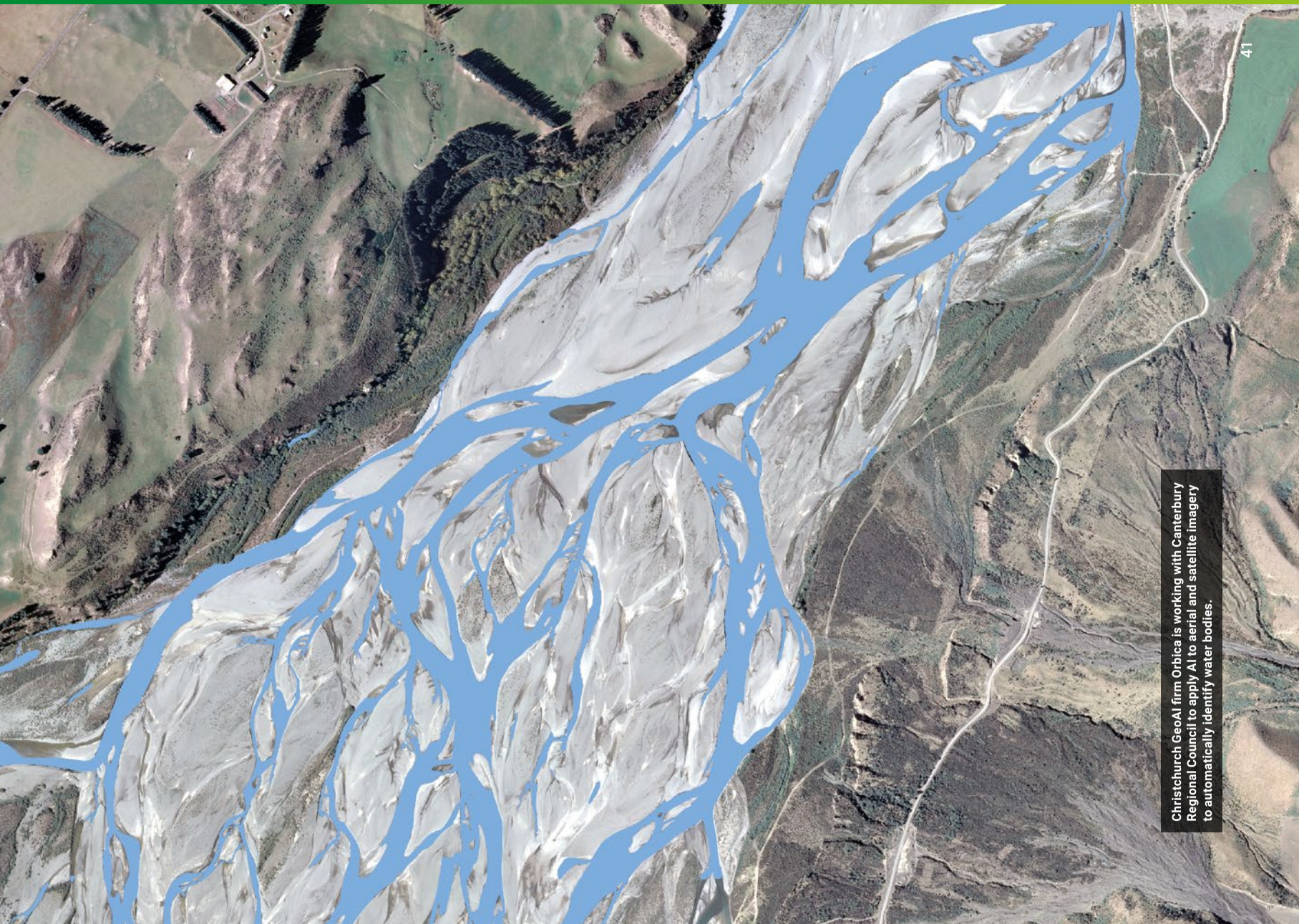
Currently, the Government is considering investing in a new national platform to deliver national research capability in big data and analytics as part of the Strategic Science Investment Fund (SSIF).[27] The platform would focus on fundamental data science, underpinning tools and techniques such as machine learning, evolutionary computing, visualisation, text mining, big image processing and ultra high speed data processing. The objective is to grow the scale, excellence and impact of New Zealand data science research. At the same time, this will strengthen the research to application pipeline within New Zealand.

A proposal is also being developed by the universities to create a National Centre for Data Technologies and Artificial Intelligence to help address the lack of national coordination and attract funding for AI research. Ultimately, any strategy and investment should encourage research to meet the rapid pace of commercial AI development needed by the economy.

[25] Media Release: $35 million for Entrepreneurial Universities. Minister Joyce, New Zealand Government, July 2016.

[26] Microsoft expands artificial intelligence (AI) efforts with creation of new Microsoft AI and Research Group. Microsoft News Center, September 2016.

[27] Strategic Science Investment Fund Investment Plan 2017-2024. Ministry of Business, Innovation and Employment, June 2017.



Christchurch GeoAI firm Orbica is working with Canterbury Regional Council to apply AI to aerial and satellite imagery to automatically identify water bodies.

PART TWO:

AI and the Economy

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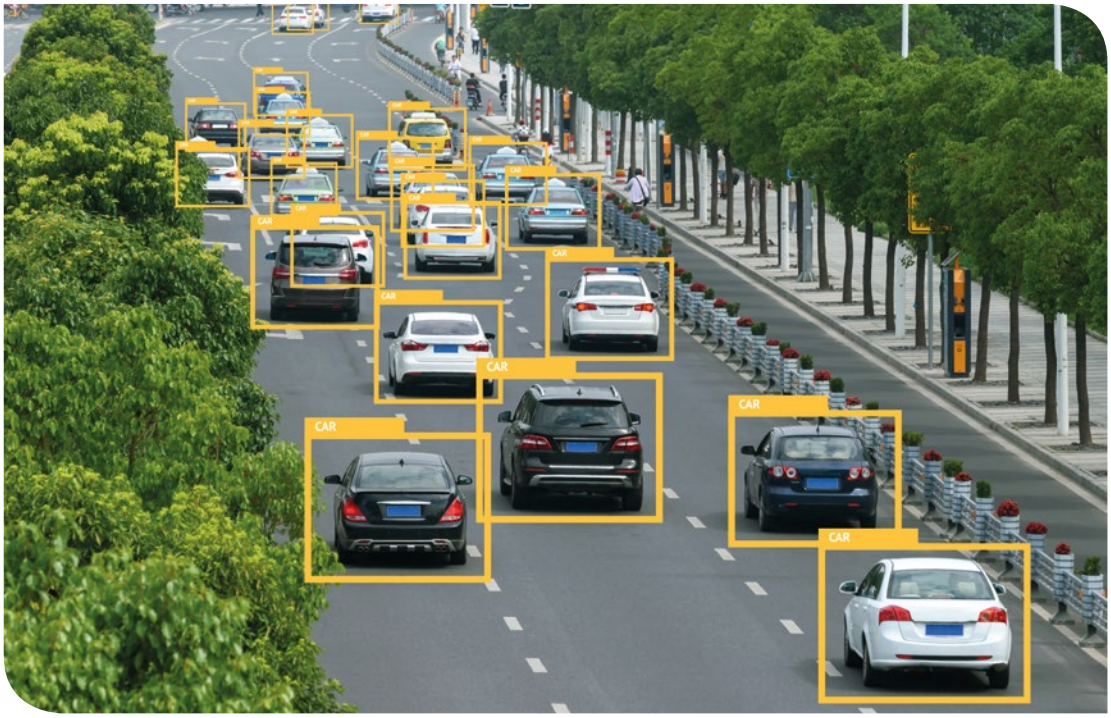
PART TWO: AI and the Economy

There is general consensus from our respondents and international research that AI will have a significant impact on economic growth and productivity.

However, the exact scale of the impact is difficult to predict. The immense potential of AI across the economy, as an emerging technology, means estimating its impact is at peril of calculating a number so large, it may appear simply unbelievable. However, some international estimates have been made, including a calculation by Accenture that by 2035, AI will add an additional US$15.7 trillion to the global economy[28].

To better understand the economic potential of AI for New Zealand, the AI Forum engaged Sapere, an independent economic consultancy, to undertake an analysis. Sapere reviewed 58 recent research papers on AI, providing an overview of current thinking with respect to economic effects, labour market impacts, productivity effects and policy implications. A literature review and analysis has been published separately, *"The Potential Economic Impacts of AI – Literature Review"*, available on the AI Forum website **www.aiforum.org.nz**.

To provide insight into the growth opportunities for individual sectors across the New Zealand economy we have included a discussion of the scale of potential benefits, based on international comparisons. An analysis is also made of the potential benefits from the automation of routine tasks and the liberation of labour to work on higher value tasks.



[28] Why Artificial Intelligence is the Future of Growth. Accenture, October 2016.

The Potential Economic Benefits of AI in New Zealand

Potential Benefits Across the Economy

AI has the potential to drive numerous economic benefits across most sectors, from improved labour productivity, more efficient development of products and services, to increased consumer demand. Described as an entirely new factor of production, lifting profitability, AI is expected to revolutionise how businesses compete and grow.

Global research by Accenture[29] estimates the potential economic impact of AI in gross value added (GVA), a close approximation of gross domestic product which accounts for the value of goods and services produced. The research analysed 12 developed countries and compared the expected economic growth rates of 16 industries in 2035, to an AI scenario showing expected growth with AI integrated into economic processes.

It is predicted that AI has the potential to increase economic growth rates by a weighted average of 1.7% across all sectors. The research also found that AI has the potential to boost rates of profitability by an average of 38% and could lead to an economic boost of US$14 trillion in additional GVA across these 12 nations by 2035.

Of the industries studied, information and communication, manufacturing and financial services will see the highest annual GVA growth rates in an AI scenario, with 4.8%, 4.4% and 4.3% respectively by 2035. Even labour intensive sectors such as education and social services, where productivity growth is traditionally slow, will see a significant increase in GVA.

Potential Economic Benefits of Automation

The AI Forum's research partner Sapere analysed 18 industry classifications in New Zealand to determine how quickly they are expected to embrace AI and the resulting economic benefits of labour conversion. Across these industries, it is estimated that the total potential impact of AI with regard to labour

> *"Artificial Intelligence (AI) heralds a new technological era, but we are yet to see its transformative potential realised in economic terms. It will alter the factors of production, reshaping jobs and our view of work, productivity and value creation".*
>
> **SHARON ZOLLNER,** Chief Economist, ANZ

SPEEDING UP TEST RESULTS

Farmers often require analysis of soil or plant samples to understand certain properties, such as nitrogen availability in the soil. *Traditionally, soil testing can take three to four days with a large amount of human intervention. The University of Waikato has developed a technique using Near Infrared Spectroscopy signals alongside AI modelling to provide an accurate result, within minutes. This technique quickly provides farmers with information, while reducing human processing effort. This is just one example of the many ways of IoT and AI are increasing farming efficiency. As a result, costs are reduced and resources are able to be redeployed into higher value tasks.*

[29] How AI Boosts Industry Profits and Innovation. Accenture, June 2017.

Tech Sector

The tech sector has among the greatest potential for economic growth from AI. Integrating AI into legacy information and communications systems is expected to quickly deliver significant cost, time and process related savings. High growth areas within this industry are cloud, network and systems security (including defining enterprise wide cloud security strategies).

Manufacturing Sector

As manufacturing is expected to be one of the major adopters of the Internet of Things (IoT) this will be a powerful catalyst for AI use. Based on the proliferation of IoT devices and the networks and terabytes of data they generate, it is predicted that AI will contribute to a strong growth in profitability for the manufacturing sector. Supply chain management, forecasting, inventory optimization and production scheduling are all areas AI can make immediate contributions to this industry's profits and long term economic outlook.

Financial Sector

The financial services sector's greatest gains from AI will come from automating and reducing errors in mundane, manually intensive tasks including credit scoring and first level customer enquiries. Additional areas of automation include automating customer service queries through intelligent bots, and scoring and reviewing mortgages.

Primary Sector

As global competition evolves for non-traditional products like synthetic proteins, AI will be an essential enabler of the precision agriculture required to produce higher quality product sustainably. Given the relatively low absorptive capacity[30] for technology, coupled with a small workforce, AI is expected to have a less direct impact on profitability. However, if the sector can accelerate its uptake of IoT, this will form the foundation for AI supported precision agriculture required to maintain global competitiveness and profitability.

Education Sector

AI will drive a significant change in the process of education by 2035. As one of the most labour intensive sectors, it is expected that AI will greatly improve the productivity of education. Personalized learning programs and automating mundane, routine tasks will enable teaching staff to develop new learning frameworks.

Tourism Sector

The tourism, accommodation and food services sectors are manually intensive. Often isolated processes will benefit from AI's increased insights and contextual intelligence. There are considerable profitability gains to be realised through labour productivity improvements alone. Also, the ability to intelligently analyse growing New Zealand tourism activity datasets will provide opportunities to design more personalised visitor experiences.

[30] The 'absorptive capacity' of businesses; their ability and incentive to adopt new technologies (refer appendix).

conversion by 2035 will be between $22.5 billion and $53.6 billion (measured in 2015 dollars).

Essentially, economic benefits are derived from the ability of AI driven systems to substitute at least some of the human labour inputs. Underlying this analysis is the assumption that human labour replaced by AI is reallocated to other productive tasks within each industry. The estimates also depend on these six key factors:

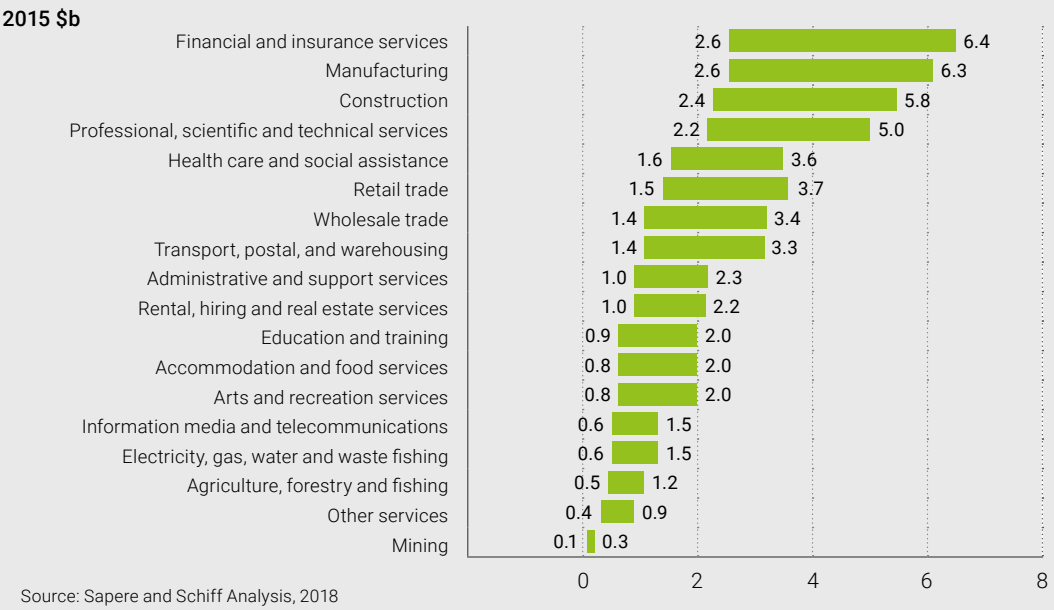
- the potential of AI to be a substitute for human labour inputs, depending on the types of jobs performed in each industry.
- the 'absorptive capacity' of businesses; their ability and incentive to adopt new technologies.
- the overall relative importance of labour as a factor of production.
- the rate of growth of the available human labour force.
- the general rate of improvement of technology.
- the real rate of change in the cost of computer technology used to implement AI, which affects the rate of AI 'labour force' growth.

The variability of these factors results in differing estimates of the AI impact across industries. Due to considerable uncertainty of industry adoption of AI, both low and high estimates are provided in Figure 4. (Please refer to the appendix for further information on our methodology).

Sectors that currently have a large labour force and high use of technology are most likely to benefit from AI. Meanwhile, sectors like agriculture, with relatively small labour pools and relatively low technology penetration, can expect less direct benefit from AI created labour efficiencies.

The estimates are a guide to the potential importance of AI in each industry after technology has matured to the point of significant adoption by a number of New Zealand firms.

Figure 4 – Estimated Ranges of Economic Benefits of Labour Efficiencies from AI in New Zealand Industries in 2035



Source: Sapere and Schiff Analysis, 2018

The Potential Labour Market Impacts of AI in New Zealand

There are differing views on the impact of AI on jobs. Some believe AI will create more jobs than it displaces, whereas others argue a large proportion of jobs will be rendered obsolete. While both are educated guesses, based on various assumptions, it is likely that some of both will occur. That is, more routine roles will be disrupted and new roles we can't currently imagine will be created. We can also gain a sense of the impacts by comparing the adoption of AI to other technologies.

The Creation of Jobs

There are two ways that AI can create jobs:

1. **Directly, in the AI producing sector.** People will be required to create, maintain and improve AI technologies.
2. **Indirectly in other sectors.** People will be required to use and oversee technology in situations where it does not completely replace humans. For example, in the way humans assist at automated airport check-in and supermarket checkouts.

To estimate the potential of new direct roles in the AI producing sector, we can assume the number of AI jobs in New Zealand would be no larger than the number of people who work in ICT occupations, since AI is just one subset of the broader set of ICT technologies.

ICT occupations in New Zealand accounted for 72,208 jobs in 2015[31], up from 47,606 ten years before. ICT jobs accounted in total for about 3% of all jobs in 2015, growing about 4% a year, three times faster than employment as a whole. At that growth rate, the number of ICT jobs will double every 18 years. If it were safe to assume that growth continues, by 2055 direct ICT roles are expected to account for at least 300,000 jobs. Obviously, AI won't account for all new ICT jobs, since that would assume that it took over all other technologies, nevertheless we can expect a significant number of new roles will be produced by growth in AI and the tech sector in general.

There is no straightforward way to estimate the second effect, indirect creation. Over the last 30 years, computers have been integrated in almost every business and now, nearly every job involves an element of working with technology. We could imagine that the same might eventually be true of AI, with some workers being highly proficient at using AI tools in their work and others still uncertain about how to do even quite simple things. If this is how AI evolves, then every job will ultimately incorporate an element.

Incorporated across different sectors, the expected productivity improvements and more efficient use of resources, along with consumer demand, are anticipated to stimulate the development of new products and services, indirectly creating new jobs. For another perspective, in a comparison of occupations in the USA in 1999 with those in 2014[32] it was found that approximately 500,000 people worked in occupations in 2014 that did not even exist 15 years before. The total USA labour force growth was 17 million between 1999 and 2014, which means new roles that didn't exist only 15 years ago, accounted for about 3% of total job growth.

Solving a Demographic Challenge

The clever introduction of AI may help address potential labour shortages and solve a looming demographic challenge. A number of sectors have highlighted their aging workforce and the expected risks for society if this is not proactively addressed. Some sectors are reporting an annual decline with more workers retiring, than entering these roles. This is particularly evident in healthcare and education with growing shortages of various healthcare workers and teachers.

The ability of AI to automate routine tasks may present an opportunity for its use in helping to offset this shrinking labour pool in these and other sectors. The imperative of continued improvement to social services in the face of increasing labour pressures is expected to drive investment into systems to support the remaining workers.

[31] New Zealand Sectors Report Series, Information and Communications Technology. Ministry of Business, Innovation and Employment, New Zealand Government. May 2017.

[32] AI, Robotics, and the Future of Jobs' Pew Research Center. August 2014.

AI Created Job Loss

Many recent research papers have warned of job losses due to AI and automation, however few refer to a specific timeframe in when these losses will occur. Some refer to 'the next decades'[33] while others suggest 'by 2055, but this could happen up to 20 years earlier or later'[34]. A New Zealand specific paper from NZIER[35], constructed by applying the job loss effects estimated by Frey and Osborne to local data, predicts that 46% of jobs will cease to exist over the next decades.

While this and other international figures on job replacement, as high as over 50% provide sensational content for the media, they lack context. What does a loss of 50% of jobs actually mean for a country? The critical context is how fast this could happen and what roles will be affected.

Advancing Technology does not Accelerate Job Losses

Contrary to popular perceptions, rapidly advancing technology does not in fact accelerate job losses. The types of tasks where humans are expected to have enduring cognitive advantages over computers tend to be described as 'non-routine' and include creativity, initiative, leadership or assisting others. More 'routine' tasks are prone to automation. The jobs most at risk are those that are already highly automated. During the last 30 years, in most developed countries, there has been growth in employment and wages for low and high skill non-routine tasks, and reduction or slower growth in employment and wages in middle skill routine jobs. The core job tasks of these occupations in many cases follow precise, well understood procedures. Consequently, as computer and communication technologies improve in quality and decline in price, these routine tasks are increasingly systematised and performed by machines[36].

Interestingly, technological advances continue to change what can be automated. Tasks that were previously considered non-routine may soon be defined in a way that makes them susceptible to automation. For example, not so long ago, driving was identified as something that computers would struggle to achieve.[37] Technology has improved and now driverless vehicles are approved for use in some jurisdictions. Other examples include playing games such as Go or Jeopardy, and writing articles or business reports directly from data feeds.

However, while computers are becoming more capable, the labour market continues to evolve too. For example, Canadian workers were less at risk of losing their jobs to automation in 2017 than they were in 2013[38], reflecting developments in technology and stronger growth in non-routine jobs than routine ones.

Studies show that there is a correlation between these types of innovation. Automation that reduces human employment, reduces the returns on further automation, so firms find new more productive ways to use humans instead[39].

An Australian[40] study examined the impact of computer based technologies on employment over recent decades. It found the total amount of work available has increased since the introduction of computers and job turnover has not increased alongside the use of computer technologies. Their suggested explanation for why techno-phobia has such a grip in popular culture is the belief that 'we live in special times'.

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[33] The Future of employment: how susceptible are jobs to computerisation. Frey, C. and Osborne, M. September 2013.

[34] Artificial Intelligence, the next digital frontier? McKinsey Global Institute, June 2017.

[35] Disruptive Technologies Risks & Opportunities - Can New Zealand make the Most of Them? NZIER, October 2015.

[36] The Shifts- Great and Small- in Workplace Automation Frontiers. MIT Sloan Management Review, Autor, D. August 2016.

[37] The New Division of Labor: How Computers Are Creating the Next Job Market. Levy, F. & Murnane, R. 2004.

[38] Future Shock? The Impact of Automation on Canada's Labour Market. Oschinski et al, March 2017.

[39] The race between machine and man: implications of technology for growth, factor shares and employment. National Bureau of Economic Research, Acemoglu, D & Restrepo, P. June 2017.

[40] Are robots taking our jobs? Australian Economic Review, November 2017. [41] The second machine age. Brynholfsson, E & McAfee, A. 2014, page 102.

AI Adoption will Take Time

Assuming job losses were to occur, it would be catastrophic for the economy if they were to occur too fast. First, AI technology must be adopted by businesses, who will then need to identify ways to transform their businesses to harness the new capabilities. The question is, how long will this transformation take? As shown in Table 1, New Zealand is typically ranked in the top 20 countries for openness to technology. This suggests New Zealand does have a propensity to adopt new technologies as they emerge.

Another way to gain a sense of AI adoption is to compare it with other technology waves. For example, mobile phones, household broadband and business Internet use all took approximately 13 years from initial availability to widespread adoption, as shown in Table 2. If AI evolves in a similar manner to other types technology, then mass adoption by businesses is likely to take at least 10 to 15 years.

Admittedly, connecting to broadband Internet is one step, using it productively is another. Businesses need to also develop new behaviours and production processes to take advance of new technology. It is this second step, that takes longer, but generates greater economic gains.

The necessity of large complementary investments in process changes is a well understood factor in the economics of technology. For example, the benefits of electricity for factory productivity were not realised until factories were redesigned. At first, firms replaced their steam engines with electric models. It took another 30 years and a new generation of factory

Table 1 – New Zealand Performance in Global Innovation Rankings

MEASURE	YEAR	RANK	CREATOR
Networked Readiness Index	2016	17	World Economic Forum
Global Innovation Index	2017	21	Cornell University, INSEAD, WIPO
Global Competitiveness Index	2017-18	13	World Economic Forum
Global ICT Development Index	2017	13	ITU (part of the UN)
Web Index	2014	12	World Wide Web Foundation
Digital Evolution Index	2017	14	Tufts University

Sources: World Economic Forum, Cornell University/INSEAD/WIPO, ITU, World Wide Web Foundation

Table 2 – Adoption Times for Other Technology in New Zealand

TECHNOLOGY	TIME PERIOD TO MASS ADOPTION	YEARS TO MASS ADOP TION	POPULATION UPTAKE
Personal mobile phones	1994 to 2007	13	102% of people
Household broadband	2003 to 2016	13	89% of households
Business ICT use	1999 to 2012	13	94% of businesses

Sources: Commerce Commission, OECD Broadband Portal, Stats NZ Business Operations Survey

designers before a move away from the centralised power model of the steam engine, where machines had to be near the central drive-shaft turned by the engine, to a design based on a production line with smaller electric motors at each stage[41].

In a recent New Zealand study[42], essentially all businesses reported using computers and the Internet, but generally they were not yet using them for tasks that could transform marketing, sales or internal operations as can be seen in Table 3.

If AI evolves like other technologies, then even if it takes 15 years for most firms to start using it from the point of widespread availability, it will take much longer before they really begin to take advantage of its possibilities. As a result,any significant labour reduction effects will be spread across a long time period.

This analysis causes us to question whether a couple of decades is really enough time for AI to eliminate nearly half of the existing jobs in the New Zealand labour market? An estimate more in line with historic changes would be closer to 40 years. Regardless, over a time period of 20 to 40 years there would be significant natural changes in the labour market.

AI Will Not Lead to Mass Unemployment

The number and type of available jobs is constantly changing, partly influenced by wider changes in economic structure. These trends are most easily seen in the long term, as shown in Figure 5.

- At the end of the 19th century, nearly 40% of New Zealanders worked in the primary sector (agriculture, forestry or fishing). The proportion is now approximately 7%. Over time, a third of the working population had to find new jobs as the nature of primary sector employment changed.
- In more recent times, employment in goods producing sectors, including manufacturing, peaked at 38% in 1966 and is now at half this level.
- The reduction in primary sector and manufacturing employment has been replaced by growth in the services sector, which now accounts for approximately 74% of all jobs, up from less than 50% only fifty years ago.

Although these were very substantial changes in the structure of our economy, they did not lead to large

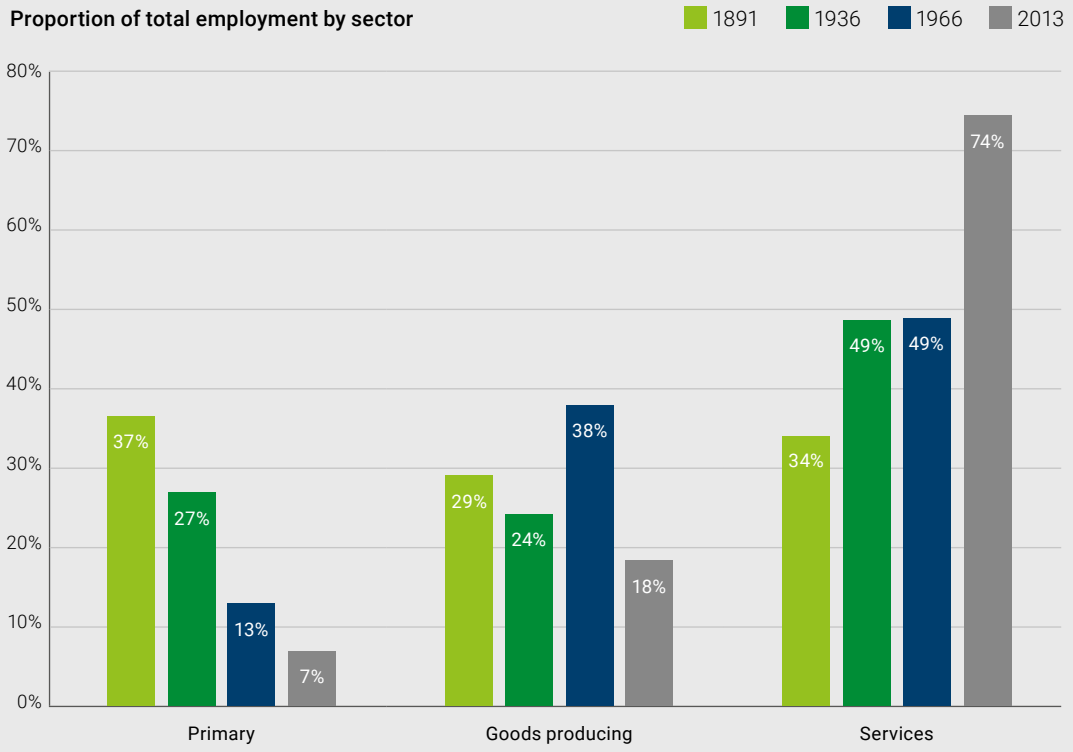
Table 3 – Businesses Using Internet for Transformation

MEASURE	PERCENT OF BUSINESSES (2012)
Using Internet at all	96
For finance	90
For Government payments	77
For online orders	77
Have website	69
Making sales online	34
Internet sales more than 10% of total	11
Have sales outside New Zealand	10

Source: Stats NZ Business Operations Survey 2014, Glass et al (2014)

[41] The second machine age. Brynholfsson, E & McAfee, A. 2014, page 102.
[42] The value of Internet Services for New Zealand businesses. Glass, H. et al. March 2014.

Figure 5 – Long Term Changes in Employment by Sector



Source: Stats NZ, Census data

Table 4 – Number of Jobs Created and Eliminated Each Year in New Zealand 2013-2016

YEAR	JOBS CREATED	JOBS ELIMINATED
2013	512,520	469,180
2014	529,240	476,210
2015	558,650	507,800
2016	583,370	522,930

Source: Statistics New Zealand LEED Tables, 2018. Includes seasonal and temporary variations in employment.

scale unemployment. Every year businesses change the number and type of jobs they need in order to be successful. When jobs are no longer needed by firms, workers lose their jobs and most find other work suited to their capabilities or re-train. Some are supported by Government labour market transition programmes. Meanwhile, other businesses are creating new jobs every year which absorbs the available labour. This information, is presented in the Statistics New Zealand Linked Employer-Employee Data (LEED) tables. An analysis of the LEED Tables[43] shows that there are a large number of jobs created and eliminated each year (Table 4) with approximately 15% of the workforce experiencing losing their job each year.

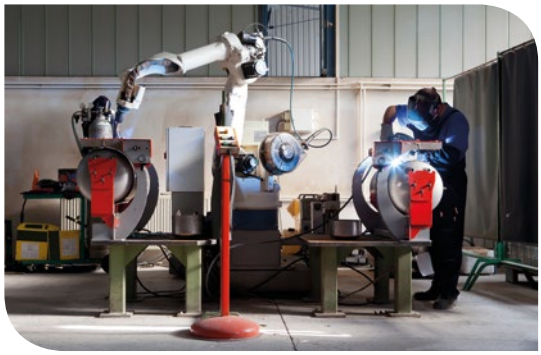
At a micro level, we can examine the fate of particular occupations. For example, in New Zealand in 1966, 21,000 people worked as typists or stenographers. Almost all of these jobs no longer exist, however this didn't result in mass unemployment of 21,000.

As technology renders some jobs obsolete and creates others, we should expect the proportion of jobs that are not as affected by technology will grow. This has occurred in Canada where the proportion of jobs at low risk of automation has grown by 35% between 1987 and 2015.[44]

In the context of this change, the loss of a million jobs over the next 20 to 40 years to AI does not appear to present an enormous labour market challenge. The New Zealand economy is continually creating new jobs and eliminating jobs that are no longer required. Over the next 40 years more than 10 million jobs will be displaced by normal market changes, so even in a worst case scenario of a million jobs lost to AI, this only represents 10% of the total change. Even if AI related job elimination were additional to the existing churn, it would be a relatively modest influence.

Implications for Policy

While widespread adoption of AI could take 15 years, New Zealand businesses in turn could take 10 to 25 years to adjust their processes in a way that is expected to fully impact employment. During that time natural



changes in the labour market will be significantly larger than any expected impact from AI. Given this, we would have to believe that there is something very different about AI related job losses compared to previous technological changes to propose any radical changes in existing policy to account for the impacts of AI. There are certainly significant and long term negative effects from technology induced job losses for individual workers. However, based on our analysis, there is no obvious reason why existing labour market support policies would not be able to cope.

Some commentators argue that due to the speed and scale of labour market change expected, AI is different to previous technology cycles. Our research does not support this view. However, if evidence of substantial negative impacts began to emerge this should provoke a reassessment of policy. A conversation to ascertain the potential 'trigger points' for further action could be a useful focus for policy discussion.

[43] Linked Employer-Employee Data Table 6: LEED measures, by firm size, December 16 Quarter. Statistics New Zealand, March 2018.
[44] Future Shock? The Impact of Automation on Canada's Labour Market. Oschinski et al, March 2017.

PART THREE:

AI and Society

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PART THREE: AI and Society

There are numerous ways that AI can improve New Zealand society and this section will consider the potential impacts for; education, healthcare and the environment.

For each we also need to consider potential challenges that AI can bring for society such as impacts on jobs, algorithmic bias, transparency, accountability, safety and ethics.

While we do not yet know what long term impacts AI will have on society, we do expect that it will be significant.

Most New Zealanders are ambivalent about AI and its impact on the future. Our research found that 68% of respondents were concerned about the potential for AI to make biased, unfair or inaccurate decisions. However, the research also found that only 15% of firms planning to use AI intend to establish some form of AI ethics committee.

As New Zealand begins to use more AI, it is important that as a nation, we have considered both the possible societal opportunities as well as potential negative implications of AI. If New Zealand does not consider the societal, legal or ethical implications of AI, then there is greater possibility that AI deployments will have unintended consequences. At the same time, if applied effectively, AI has the potential to provide significant positive societal benefits.

AI AND MĀTAURANGA MĀORI

New Zealand should also consider AI in the context of its cultural heritage. *Our research involved speaking with Māori leaders who are technology advisors and protectors of Matauranga Māori. Like New Zealand in general, the Māori perspective of AI is fragmented with little awareness or consensus about AI.*

Knowledge is important in Māori culture and data holds the same significance as knowledge. Storage, ownership, access and security of data are essential topics for AI discussions.

Language and verbal communication are also vital to Māori. AI can potentially benefit Māori language revitalisation, for example Northland radio station Te Hiku Radio is creating language tools that will enable speech recognition and natural language processing of Te Reo Māori.

Culture also requires context, in that what is important to some won't impact all. From a Māori perspective, everything has a life force (Mauri) and AI has its own particular Mauri. However, for the Iwi, our research participants said that there are no real cultural considerations as the Iwi operate in the same manner as any commercial business so their concerns will be similar to the private sector.

Māori will need active engagement in discussions regarding AI in New Zealand, particularly in relation to the societal implications of AI as they are likely to be overrepresented in roles that may be affected by AI driven change.

INTERNATIONAL CONNECTIVITY: PARTNERSHIP ON AI

The international Partnership on AI to Benefit People and Society was established in 2017 by global tech giants Alphabet (Google), Amazon, Apple, Facebook, IBM and Microsoft. *The partnership aims to study and formulate best practices on AI technologies, to advance the public's understanding of AI, and to serve as an open platform for discussion and engagement about AI and its influences on people and society. The Partnership on AI areas of focus include harnessing AI to contribute to solutions for some of humanity's most challenging problems, including making advances in health and wellbeing, transportation, education, and the sciences. The AI Forum of New Zealand joined the partnership in late 2017 and members are actively engaged with its workstreams its workstreams including these thematic pillars:*

Partnership on AI
to benefit people and society

1. **SAFETY CRITICAL AI**
2. **FAIR, TRANSPARENT AND ACCOUNTABLE AI**
3. **COLLABORATIONS BETWEEN PEOPLE AND AI SYSTEMS**
4. **AI, LABOUR AND THE ECONOMY**
5. **SOCIAL AND SOCIETAL INFLUENCES OF AI**
6. **AI AND SOCIAL GOOD**

The Potential of AI for Society

There is real potential for using AI to help ensure a fair, inclusive and thriving society throughout New Zealand. The ability for personalisation of education and healthcare in particular, will have a profound effect on New Zealanders lives.

The application of AI can also support social outcomes such as improving social justice and reducing inequality. The ability for personalisation of services, such as education and healthcare, in particular, will have a profound effect on New Zealanders lives. There is real potential for using AI to help ensure a fair, inclusive and thriving society throughout New Zealand.

AI and Education

The application of AI is set to transform the delivery of education. However, we also need to consider what future students will need to learn, to be productive members of society in an advanced Digital Nation.

AI Driven Personalised Learning

AI will be a catalyst for a substantial paradigm shift from mass standardised education to personalised learning. Enabled by AI, student progress can easily be monitored by teachers. Teachers can then deliver individually tailored learning to lift performance in required areas while encouraging students to delve into other areas they excel in. Data can be aggregated to provide teachers with a snapshot of how the class and individuals are progressing. The data will also provide guidance to help them adjust teaching for maximum outcome.

Ultimately, AI will provide an alternative way of delivering education and this also applies to the corporate training market. Human capital development through training could be greatly assisted with AI. Today, identifying and developing talent within an organisation is often ad hoc. Using AI to develop and advance employees will lead to better supported and more productive workers. In a skills shortage, these employees may be more likely to stay with a company that invests in them through developing their skill set.

AMY, THE AI TUTOR

Jaipuna is a New Zealand based tutoring business who created Amy, an AI tutor for high school students. *Amy offers one-on-one, interactive tuition with real time feedback on student progress. Amy tailors the learning process to each student, giving personalised feedback and filling in the gaps in the student's knowledge. Amy also uses data from across multiple students to improve her overall teaching abilities. Teachers can use Amy to set individual tests for students, which are automatically marked. Jaipuna plans to develop support for students with different learning capabilities and add in voice communication so that Amy can speak to students.*

Lifelong Learning and Mid-life Retraining

The traditional model of 'learn, work, retire' will become increasingly redundant as AI and other automation technologies reshape the way we engage with work as a society. Some current roles will be reshaped, others displaced and entirely new roles created. Regardless of individual role changes, access to lifelong learning will become increasingly essential.

In the years to come there will be a growing need to retrain adult workers. Our research participants suggested that New Zealand does not currently offer enough appropriate retraining options. Individualised AI powered learning systems could be developed to help individuals at all stages of their working life who need to upskill.

Growing our AI Talent Pool

Like most other advanced economies, New Zealand is experiencing a growing shortage of computer science graduates. A recent study of the New Zealand digital skills landscape[45] found that only 5,090 computer science or information technology students graduated in 2015, yet the tech sector created almost 14,000 new jobs in 2016. The fastest growth in demand was forecast for machine learning. This research also found that machine learning was also the most in demand skill with the fastest demand growth in Silicon Valley, New York and London. The report concluded that we need to urgently focus on increasing the number of graduates produced in New Zealand.

The Digital Skills report provided a number of recommendations for building a tech talent pipeline, all of which are relevant for the development of an AI talent pool in New Zealand, including:

- make sure every child is exposed to digital technologies at school.
- help Kiwis understand the importance of digital skills.
- conduct a national campaign to increase the numbers studying advanced digital skills.
- actively encourage more diverse groups into digital technology.
- undertake a programme of constant digital attraction throughout global markets.

Developing New Valued Skill Sets

As AI automates process driven job functions, the ability to think critically and creatively are key traits that people need to develop. New Zealand has begun this transition, with the introduction of 'innovation labs' where employers value creativity and critical thinking. While STEM (science, technology, engineering and maths) is important, we should also encourage STEAM (science, technology, engineering, arts and maths) to develop creative thinking skills required for the future.

AI and Health

There is immense potential to save both lives and money through the use of AI systems. It is estimated that algorithms could save the global health sector up to US$100 billion[46] a year, as a result of AI assisted efficiencies in clinical trials, research and better decision making in the doctor's office.

The health system produces a substantial amount of data and imagery while reporting high levels of inefficiency, making it ideal for the application of

[45] Digital Skills for a Digital Nation. New Zealand Digital Skills Forum. December 2017.
[46] How big data can revolutionize pharmaceutical R&D. McKinsey & Company, April 2013.

AI. While the OECD estimates that about 20% of health spending in OECD countries is wasted,[47] AI is only just beginning to change the way health professionals diagnose, treat and monitor patients.

AI systems can be deployed in health in numerous ways, including:

- mining medical records to provide more personalised, better, faster health services.
- designing personalised treatment plans.
- assisting in repetitive jobs such as reviewing scans or laboratory results.
- supporting the delivery of virtual and online health services.
- providing health assistance and medical management.
- developing precision and genomics based healthcare.
- designing new drugs and medical therapies.
- improving health system processes such as scheduling, billing and customer service.
- providing low-cost access to mental health counselling services.

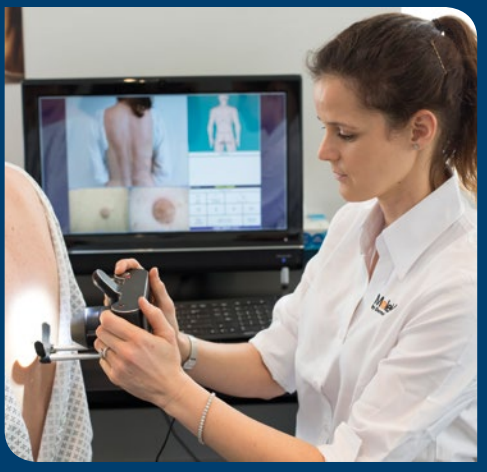
Early adopters within New Zealand's health system are deploying AI on the fringes of the public system. Currently, there is no Ministry of Health or New Zealand Medical Council policy on the use of AI. The Royal New Zealand College of General Practitioners recently published a position statement[48] advocating the adoption and effective use of technology (such as telehealth) to assist general practitioners (GPs) to provide safe quality healthcare, as long as it was complementing the doctor not replacing them. There was no specific mention of AI in the position statement.

The high costs of healthcare, coupled with shortages in medical professionals, an increasing elderly population and high consumer service expectations mean it is likely that AI supported health solutions will rapidly become available. It is further expected, that the national health system will continue to adapt at a slower pace and new technology will be privately supported.

IMPROVED SKIN CANCER DETECTION

New Zealand currently has the highest rate of melanoma in the world. *However, there are insufficient qualified dermatologists to cope with skin checks for everyone in New Zealand.*

MoleMap is a New Zealand based private dermatology company that offers clients top to toe mole scanning and diagnosis services. The task of checking every image of a suspicious mole is onerous, so MoleMap decided to partner with IBM Research to explore how AI may help clinicians distinguish regular moles from those with the potential to be cancerous. The MoleMap system helps dermatologists screen false alarms, allowing them to check only the images the system can't confirm as negative for melanoma. AI technology conducts initial checks, reserving the more complex analysis for expert clinicians. This system has published results with 96% accuracy.



[47] Tackling Wasteful Spending on Health. OECD, January 2017.

[48] Telehealth and technology-based health services in primary care. Royal New Zealand College of General Practitioners. September 2017.

Some New Zealand health firms are already using AI, such as MoleMap, who use AI to screen images of normal moles, leaving suspicious moles for human diagnosis. Another company, Orion Health, is developing precision driven health solutions to augment its current health system software, including research on improving how deep neural networks can be applied to electronic health records (EHRs).

It is expected that the health system will be slower to change than other sectors, yet change will be driven by consumer expectations and an increasing diversity of health data sources, for example, the explosion of data from personal fitness monitoring devices. Privacy concerns remain paramount with the ongoing challenge of balancing the privacy of patient data with the opportunities for radically improved health outcomes. A continuing pragmatic conversation is required between patients, public health providers and digital health organisations to enable data accessibility for researchers. Without access to appropriate data, AI driven improvements cannot be realised.

AI and the Environment

Environmental sustainability is becoming an increasingly important topic and includes sustainable resource use, protecting native wildlife and finding new ways of using natural resources without causing damage. AI can help address our environmental concerns by analysing data and providing better

SAVING OUR NATIVE BIRDS

In September 2017, researchers at Victoria University of Wellington embarked on processing birdsong recordings. *Tens of thousands of hours of recordings were collected using acoustic sensors, as part of a three year study by researchers. Tensorflow was used to develop a system to catalogue the large number of recordings.*

Tensorflow was created by engineers and researchers at Google and is an open source software library for machine learning and deep neural networks research. The system was used to learn and recognise different bird calls, allowing the activity of species to be measured depending on various times and locations.

Using this system helped researchers to quickly analyse recordings and identify key factors affecting threatened birds such as kakariki, saddleback and hihi. Overall, it helped simplify the process and created a more accurate method of identification.

detection and environmental management tools. AI can also be used in the redesign of industrial processes to make them more sustainable overall.

New Zealand's well known environmental challenges include climate change, water overuse, river pollution, soil degradation, shrinking biodiversity, introduced predators and deforestation. For each of these issues, AI can help support evidence-based sustainable policies and practices in the future.

Today, climate change is perhaps the most urgent environmental issue facing the world. The priority to ensure that New Zealand is able to adapt to forthcoming climate change will require accurate data driven models and forecasting. NASA has gathered data for the changing conditions of the world's land surfaces and aggregated them for download at Landsat, the world's longest continuously acquired collection of space based moderate resolution land remote sensing data. The free availability of this data (and others like it) enable AI to be used to provide more accurate climate models going forward.

Long term climate and environmental datasets will be essential to train AI to detect patterns of environmental change. Investment in applied research, together with systems and sensors to collect, aggregate and publish accessible and accurate data will be crucial for these techniques to be useful.

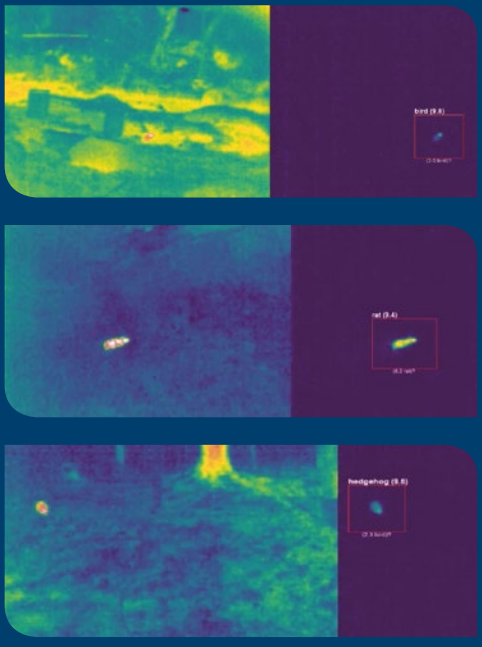
The advent of easily accessible low Earth orbit (LEO) satellite imagery is leading to many new opportunities to monitor and acquire environmental data. For example, regional council Environment Canterbury in association with geospatial firm Orbica is in early stage testing to provide more accurate information about the channels and water flows in braided rivers. They are also exploring other opportunities such as the use of LEO or drone imagery to detect plant pests like invasive wilding pines, which could accelerate their control.

In New Zealand, AI is also being used in a range of biodiversity projects. Universities are undertaking Machine learning projects including identifying and eliminating predators to help native birds populations, and bird call monitoring to identify endangered species.

AI VS THE PREDATOR

The Cacophony project aims to eliminate predators to enable flourishing native bird populations. *The open source project is creating a device that lures predators using sound and light, identifying the predator using AI and machine learning, and traps or eliminates the predator. It will measure its success by listening to birdsong in the area, over time, to see if it is increasing.*

Canterbury University students worked on the AI component of the system. They collected videos of predators such as possums, stoats and rats and used these to train the system. Approximately 95% of predators were correctly identified from images and 100% were correctly identified from video. A high level of accuracy is important in a project like this, to ensure the system traps or eliminates only the predators and not other animals.



Implications of AI

Internationally, there are a number of important conversations underway regarding the potential implications of AI for society.

In New Zealand, more discussion is needed to broaden our general understanding of the potential issues relating to AI; including bias, transparency, accountability and ethics. Situations where these issues apply do exist today and the emergence of AI is further highlighting concerns. Additionally, we need to ensure New Zealand's legal and regulatory framework keeps pace with fast moving technology driven change while enabling innovation.

The following concerns are addressed in the next section:

– AI and Employment

– AI Bias, Fairness and Transparency

– AI Safety, Accountability and Ethics

– AI Legislation and Regulation

AI and Employment

As explored above in Part Two, undeniably, the nature of jobs in New Zealand will change as organisations continue to deploy AI solutions. In many roles, AI may erase the mundane aspects of the job, enabling workers to spend more time on higher value tasks. For example, AI and robotic automation may replace repetitive factory jobs, however new roles requiring skillsets which complement AI enabled systems will be created.

"Soft skills like empathy, communication and critical thinking will only grow in importance as jobs working with [AI] systems become more common," says a recent paper on a proposed US AI Strategy[49] explicitly highlighting new human skills requirements.

> *"What I'm really excited about is the potential for people to partner with AI to improve their ability to do creative tasks, and the potential to benefit scientists and health research."*
>
> **TOMÁŠ IŽO**, Engineering Director, Google Research

More to Consider Than Just Job Numbers

Aside from net loss or gain in job numbers, society needs to consider several other job related issues. Employment considerations arising from AI include:

- Which roles are at low risk or high risk of displacements?
- Which kind of new roles might appear, and how might we predict them and the required skills? Many brand new roles, simply can't be foreseen today.
- "Today we have social media analysts, yet our parents would never have said to us 'you should train to be a social media analyst' because those jobs did not yet exist," a research participant said.
- Which jobs do we not want computers to do? For example, do we want AI teachers, or carers, or soldiers?

> *"Soft skills like empathy, communication and critical thinking will only grow in importance as jobs working with [AI] systems become more common."*
>
> **CSIS**, March 2018

[49] A National Machine Intelligence Strategy for the US. CSIS/Booz Allen Hamilton, March 2018.

- Do we want a society where people don't need to work as much? Will our society continue to define itself by the 40 hour week? People could spend more time with their families and engaged in leisure activities. However, what if this lead to feelings of lack of purpose?
- How should we connect the issue of AI's impact on jobs and the labour force to the equally important issue managing demographic change?
- Should we invest in AI research and development where we expect labour market shortages? How will this affect immigration policies?
- Does our education system help young people gain the best skills for the future?
- What is the most effective form of retraining and life long learning to support job transition?

Generational attitudes also need to be considered. For example, a recent staff survey at a New Zealand engineering firm found that millennial employees (born between 1981-1996) were focused on AI as a tool to free up their bandwidth for creativity, not as a threat to their job[50].

The 2017 OECD study[51] on the New Zealand labour market found that more workers are likely to be displaced in the future due to technological change. The re-employment rate after two years is high, however, relative to other countries, displaced workers incur larger earnings losses. Most displaced New Zealand workers do not qualify for the means-tested unemployment benefit, half do not receive redundancy pay and very few benefit from activation measures. Meanwhile, for those whose roles are displaced by AI need to afford general living expenses while retraining for re-employment.

Consideration will need to be given by Government to ensure labour market policies provide security for workers while allowing organisations the flexibility to automate to remain competitive.

> *"Most displaced workers in New Zealand do not qualify for the means-tested unemployment benefit, half do not receive redundancy pay and few benefit from activation measures."*
>
> **OECD**, 2017

AI Bias, Fairness and Transparency

Internationally, recent high profile incidents have highlighted that AI systems can develop bias. The increasing media attention, in particular, has lifted the awareness of AI bias outside the realms of the technology sector and academia.

Bias is part of our human nature, where we interpret situations and form viewpoints based on our own experiences, cultural norms, societal or religious beliefs. It is not surprising, then, that AI systems can inherit human bias through training data or algorithms within their code. Inequitable outcomes due to bias are proving to be unacceptable to society and the first piece of legislation to examine 'algorithmic bias' in government agencies was recently passed in the USA[52].

Humans Create Bias, not AI

AI systems are fed training data by their creators. If this data contains bias, then clearly the system will learn the same bias. For example[53], in the USA an AI system is used by judges to help apply the best sentence to convicted offenders, based on an AI determined reoffending risk profile. The goal is to apply the most effective sentence, to reduce the risk of reoffending, without bias. Unfortunately, the system uses historical sentencing data for training and this has led to the development of a bias against black defendants, providing a higher risk score for reoffending,

[50] NZ Engineering Company Internal Staff Survey. February 2018.
[51] Future of Work and Skills. OECD Paper for the G20 Employment Working Group. OECD, February 2017.
[52] A Local Law in relation to automated decision systems used by agencies. The New York CIty Council, December 2017.
[53] Machine Bias. ProPublica, May 2016.

"We must help citizens understand how artificial intelligence works, so they recognise that AI can serve to root out bias rather than perpetuate it. Companies must be able to explain what went into their algorithm's decision-making process. If they can't, then their systems shouldn't be on the market."

DAVID KENNY, IBM

resulting in longer prison sentences. This shows that as machine learning AI is increasingly used to make critical decisions across complex social domains, ensuring decisions aren't discriminatory is pivotal.

Bias can also be written into the code of an AI system within its algorithms. If poorly designed, the algorithms may include the bias of their developer. Recent research at MIT found that commercial face-analysing AI works significantly better for lighter faces than darker ones[54]. In another example[55], an AI was developed to judge a beauty competition. Of 6,000 entrants, the AI chose 44 winners, all except one were white. Effectively, the developers had replicated their Western-centric standards of beauty and preferences when writing the algorithms. These examples emphasise the importance of encouraging diversity within the pool of AI developers and – equally importantly – the data upon which AI is trained.

AI Transparency

Currently, there are no laws requiring the developer of an AI system to design the system so it can explain its decisions. In fact, in many cases, the algorithms are proprietary and the company who created them won't share them unless legally compelled to. However if we are to be able to trust AI systems, ideally, these systems need to be able to explain how they made a decision.

Consider an AI system that makes a recommendation to a bank on whether you qualify for a loan. In a traditional banking environment, if you weren't successful you can ask why you weren't approved for a loan and receive a reply. But if a loan is turned down by an AI system, it won't necessarily be able to explain why, even with extensive auditing features. AI systems are becoming opaque due to their increasing complexity. To enable trust in AI systems, they need to be able to explain how they made a decision. Furthermore, a process should be considered for appealing seemingly biased or discriminatory decisions.

ACC AND PREDICTIVE MODELLING

In New Zealand, the Government agency Accident Compensation Corporation (ACC) uses a computer based predictive modelling system to help its case managers make decisions about claims. *Last year, concerns were raised in the media whether the tool could be biased or whether ACC uses the tool to target clients for returning to work before they have recovered. Questions were asked about how the system made its decisions and how a client might be able to appeal the computer based decision.*

ACC said the tool was used to predict how long injury recovery might typically take to help case managers set initial expectations, but that the client's return to work was ultimately determined by medical providers. ACC also emphasised that an individual's privacy is respected.

However, ACC did not explain how the system made decisions. To develop trust in AI, there needs to be transparency, especially with AI in public services.

[54] http://gendershades.org/overview.html

[55] When beauty is in the eye of the (robo) beholder. ARS Technica, March 2017.

Not all AI systems will need to be as transparent as others. For example, an AI system that recommends medical treatment paths, will need to be more transparent than one that manages online shopping recommendations. In addition, some AI decision-making techniques are more amenable to explanation than others. The decisions of deep networks are particularly hard to explain. However, in the emerging field of 'Explainable AI', interesting methods are being developed for providing an explanation capability for any decision-making system, no matter how complex—often without revealing technical details of the system itself, which should facilitate their commercial use.

The EU General Data Protection Regulation (GDPR), which comes into effect in May 2018, includes a right to obtain an explanation of decisions made by algorithms and a right to opt out of some algorithmic decisions altogether. The GDPR is designed to address the risk of companies making unfair decisions about individuals using AI. In many cases, compliance with this regulation will depend on progress in Explainable AI research, and on uptake of Explainable AI techniques.

There is growing expectation that proprietary algorithms need to be able to explain their decisions, without necessarily making public, the proprietary mathematics. Conversely, open algorithms are public, able to be vetted by stakeholders including government, private companies and AI experts to answer questions regarding personal privacy and fair decision making.

AI Safety, Accountability and Ethics

The complexity of AI raises issues for operating in a safe manner and preventing harmful outcomes. As with any technology, this can only be achieved by carrying out rigorous testing in a wide variety of scenarios during design and development. There is added complexity with AI safety, regarding when an AI system (for example, a self-driving car) should return control to a person when a critical situation occurs.

This leads to a wider discussion of military, cyber warfare, weaponisation and other dangerous uses of AI. New Zealand needs to invest in understanding the potential threats. In particular, AI must feature in our national cybersecurity strategy – this is discussed in more detail in Section 4.

Photo credit: Lance Cpl. Julien Rodarte

Another high profile issue, currently under international consideration is the emergence of lethal autonomous weapons enabled by AI.

The Campaign to Stop Killer Robots[56] is a global coalition of non-governmental organisations working to ensure that adequate levels of human control are retained in the use of force by banning the development, production, and use of a new generation of fully autonomous weapons.

The campaign calls on all states to:

- Commit to negotiate a legally-binding ban treaty without delay to determine how and where to draw the boundaries of future autonomy in weapon systems;
- Specify the necessary human control required over the critical functions of identifying, selecting, and engaging targets and over individual attacks;
- Adopt national policy and legislation to prevent the development, production and use of fully autonomous weapons.

[56] https://www.stopkillerrobots.org/

The campaign hopes that a new international treaty can be negotiated by the end of 2019.

At their annual meeting in Geneva in November 2017[57], the 125 nations that are part of the 1980 Convention on Conventional Weapons (CCW) agreed to continue formal deliberations to deal with the challenges raised by lethal autonomous weapons systems. A group of 22 countries called for the development of new international law to prohibit and regulate these systems and an immediate moratorium on the pursuit of such weapons.

To date, New Zealand has not joined this group but recently[58] reinstated the Cabinet portfolio of Disarmament and Arms Control, indicating an openness to taking a more prominent international leadership position on these issues.

Who is Accountable?

As AI becomes increasingly widespread, a strong culture of accountability is required. Who will be answerable, culpable, liable and ultimately responsible, should anything go wrong? For example, if a driverless car is involved in an accident, who is responsible? Does the fault lie with the passenger, vehicle owner, the AI system, company who created the algorithm (or provided training data), car manufacturer or connectivity company? Is no one at fault, some of these, or all of these? Regardless of who is to blame, how will remedial actions be implemented to reduce the chance of a repeat incident? These are complex issues that need to be openly discussed and debated across society to reach an acceptable conclusion.

The recent draft report on robotics recommendations to the European Union Committee on Legal Affairs[59] discussed liability issues in the case of harm by a robot. Currently, robots cannot be held responsible for their actions; if the owners, manufacturers, or users should have foreseen and prevented the harmful action then they may be held liable. The report proposed an insurance scheme for robots and recommended discussion on whether machines should be held responsible for their actions and if so, should they possess a legal status?

Likewise, New Zealand will need to consider if AI should be subject to the same laws as a person is or whether we should place accountability with the people behind the system. When it comes to physical AI such as autonomous vehicles or robots, New Zealand is in a unique position with its nationwide no-fault scheme for injuries caused by accidents, the Accident Compensation Corporation (ACC). However, as we consider accountability issues, we will need to consider new accident scenarios arising from AI.

In addition, it needs to be recognised that that AI – like humans – needs to learn, so products using AI may not initially be perfect or up to existing standards. However, arguably AI systems should be put in to

production as soon as they are just a little bit better than the current / human alternative (e.g., to improve safety) – though even with rigorous testing, there will need to be ways to stop or disable defective AI systems. Given all of the above, there must also be appropriate groups to investigate accountability issues arising from the novel AI scenarios which are going to arrive.

Ensuring AI is Ethical

Accountability issues are closely linked with ethical concerns. Continuing with the tangible example of driverless cars, if a vehicle is about to have an accident that may result in hitting a pedestrian if it swerves or the injury of its passenger if it doesn't, what should it choose? Or should it choose at all? A human driver may be forgiven for making an instinctive but nonetheless

[57] Human Rights Watch, UN "Killer Robots" Talks Fall Short, November 2017.
[58] Dominion Post, "Reinstating a Minister for Disarmament a good sign for NZ's role in the world", March 2018.
[59] Recommendations to the Commission on Civil Law Rules on Robotics. European Parliament, January 2017.

bad split second decision, such as swerving onto the pavement rather than crossing the centre line. However, programmers of automated cars in theory have the time to get it right and because of this, more likely to be held accountable for bad outcomes.

It would be unreasonable to expect programming issues to sort themselves out without a deliberate discussion about ethics. Ethics by numbers alone seems naïve and incomplete; rights, duties, conflicting values, and other factors come into play. Which choices are better or worse than others? Is it better to save an adult or child? Saving two adults versus one child? Generally, we don't like considering these uncomfortable and difficult choices, but programmers will have to.

The German Federal Government recently announced the adoption of new guidelines for self-driving cars inside Germany. These guidelines prioritise the value and equality of human life over damage to property or animals.[61] This means a driverless car in Germany would hit whichever person it determines it would hurt less, regardless of age, ethnicity or gender. In practice, how a car will determine the damage it may cause, remains uncertain and some commentators are sceptical the recommendations will be workable.

The ethics of AI is a global issue, which is the focus of several global working groups, including The Partnership on AI. The Institute of Electrical and Electronics Engineers (IEEE), the world's largest technical professional organisations, recently undertook a global initiative to develop standards for the ethics of autonomous and intelligent systems[62]. The group prioritised ethical concerns and human wellbeing for all aspects of autonomous and intelligent technologies. These standards were released in November 2017:

- Standard for Ethically Driven Nudging for Robotic, Intelligent and Autonomous Systems
- Standard for Fail-Safe Design of Autonomous and Semi-Autonomous Systems
- Wellbeing Metrics Standard for Ethical Artificial Intelligence and Autonomous Systems

Given that German regulators have developed a set of principles for driverless vehicles, this approach could be explored further in New Zealand. A working group should be established to advocate for and provide expertise in applying principle based ethics to AI to assist end user companies, government and non-profit organisations. Meanwhile, sector specific regulators have a responsibility to develop

IMPROVING UNIVERSITY COMPLETION RATES

New Zealand's tertiary education system contributes over $3.8B to the economy every year, not to mention generates much needed skills for the future workforce. *However, there is significant financial impact on students who prematurely leave tertiary education, and the flow on effect for education providers.*

To combat this problem, Jade Software's data scientists built and optimised a machine learning algorithm that identifies students at risk of discontinuing their study. The system allows educators to provide proactive intervention and support to students who need it, reducing student dropout numbers.

The Jade team extracted and cleaned over 15 years of student record history from the university's system, consisting of 1000s of relevant data tables.

Jade then applied various machine learning algorithms to the student data, then tested and refined them in multiple iterations until they were satisfied that the model allowed the system to make accurate predictions about current students.

A percentage score indicating a student's chances of dropping out is then passed on to the university. From here the university can assess the drop out risk at an individual level, then offer students appropriate support to stick with their studies.

[60] The Trolley Problem. Thomson, J. The Yale Law Journal, Vol. 94, No. 6 May, 1985.
[61] Federal Government adopts action plan on automated driving. Federal Ministry of Transport and Digital Infrastructure, June 2017.
[62] The IEEE Global Initiative on Ethics of Autonomous and Intelligent Systems. IEEE Standards Association, November 2017.

sufficient understanding of AI as it applies to their industry. For example, New Zealand's Ministry of Transport and NZTA have been exploring driverless cars and intelligent transport issues since 2014.[63]

AI Legislation and Regulation

Until now, when making law, lawmakers have not taken into consideration machines with human-like abilities. For many commercial systems, the issue of law and regulation relating to AI operates at a global scale. Most countries are having similar conversations and international forums like The Partnership on AI and political organisations like the United Nations may be the best platforms to lead these discussions. One New Zealand-based academic advocates a specialist inter-governmental organisation to promote a uniform international approach to AI regulation, with the potential for New Zealand to take a leading role as a neutral host nation[64].

However, at some point New Zealand lawmakers will need to consider local legislation with regards to legal responsibility, agency and causation. While pre-emptive regulation might be well intentioned, it has the potential for unintended consequences and may risk removing New Zealand's international competitiveness. One of the perceived strengths of our common law system is its ability to evolve to respond to new situations.

AI Law and the Business Response

AI presents a significant opportunity to make legal services more widely accessible and inclusive through the widespread deployment of AI based automation – "robo-lawyers" in the popular imagination.

Regardless of new law or regulations, some industries will need to reconsider how the law applies to them in an AI environment. Our research participants all agreed that New Zealand businesses also need to start understanding potential legal implications stemming from the use of AI and begin addressing them now, in order to ensure no unnecessary barriers

> *"Initially, AI requires us to consider and adapt regulation in specific domains, such as for autonomous vehicles or robotic medicine. Over time, we will have to wrestle with the implications of AI for core legal principles like legal responsibility, agency and causation."*
>
> **BRUCE McCLINTOCK**, Chapman Tripp

AI AND NEW ZEALAND LAW

In 2017, the New Zealand Law Foundation established and funded a three year research project to evaluate some of the legal and policy implications of AI for New Zealand.

The project, based at the University of Otago, currently focuses on uses of AI systems in the criminal justice system and in government departments more generally. Drawing on discussions in New Zealand and overseas, the project has recently[64a] recommended an agency be established in New Zealand, to oversee the use of predictive AI systems ('predictive analytics') by publicly funded bodies. The agency would publish a complete list of the predictive tools used by New Zealand government departments, and other public institutions such as ACC. In addition it would regularly evaluate the accuracy of these tools, check their decisions for bias, assess their support for explanations, and monitor how human users are trained to use them.

[63] Position Statement on Intelligent Transport Systems - responding to the opportunities. New Zealand Transport Agency, April 2014.

[64] Regulating Artificial Intelligence: Proposal for a Global Solution, Olivia Erdelyi (now at University of Canterbury) and Judy Goldsmith, February 2018.

[64a] http://www.scoop.co.nz/stories/SC1804/S00027/time-to-consider-a-regulatory-body-on-ai.htm

are established prevent the opportunity of AI being realised. For example, compared to other countries, New Zealand businesses do not have the same legal copyright protection that is necessary for data mining. This arguably places local businesses at a perceived disadvantage to competitors overseas.

In general, research participants consider there is currently not enough thought of the legal or regulatory implications of AI. They urged it be addressed proactively, to avoid unintended implications such as reduced global competitiveness. At a practical level, it appears that as more automated systems are deployed, regulators are examining issues as they arrive. For example, the Ministry of Transport's work on Intelligent Transport Systems.

The Allen Institute for Artificial Intelligence have developed three rules for regulating AI[65], which could be used as a basis for discussion in New Zealand. These include:

1. an AI system must be subject to the full gamut of laws that apply to its human operator.
2. an AI system must clearly disclose that it is not human.
3. an AI system cannot retain or disclose confidential information without explicit approval from the source of that information.

These rules could help ensure New Zealand reduces the risk of an AI taking part in a criminal activity to achieve its goals, or for its goal to be something criminal in nature, for example, cyberbullying or fraudulence. The requirement for non-human disclosure reduces misrepresentation.

ROBO-ADVICE IS COMING

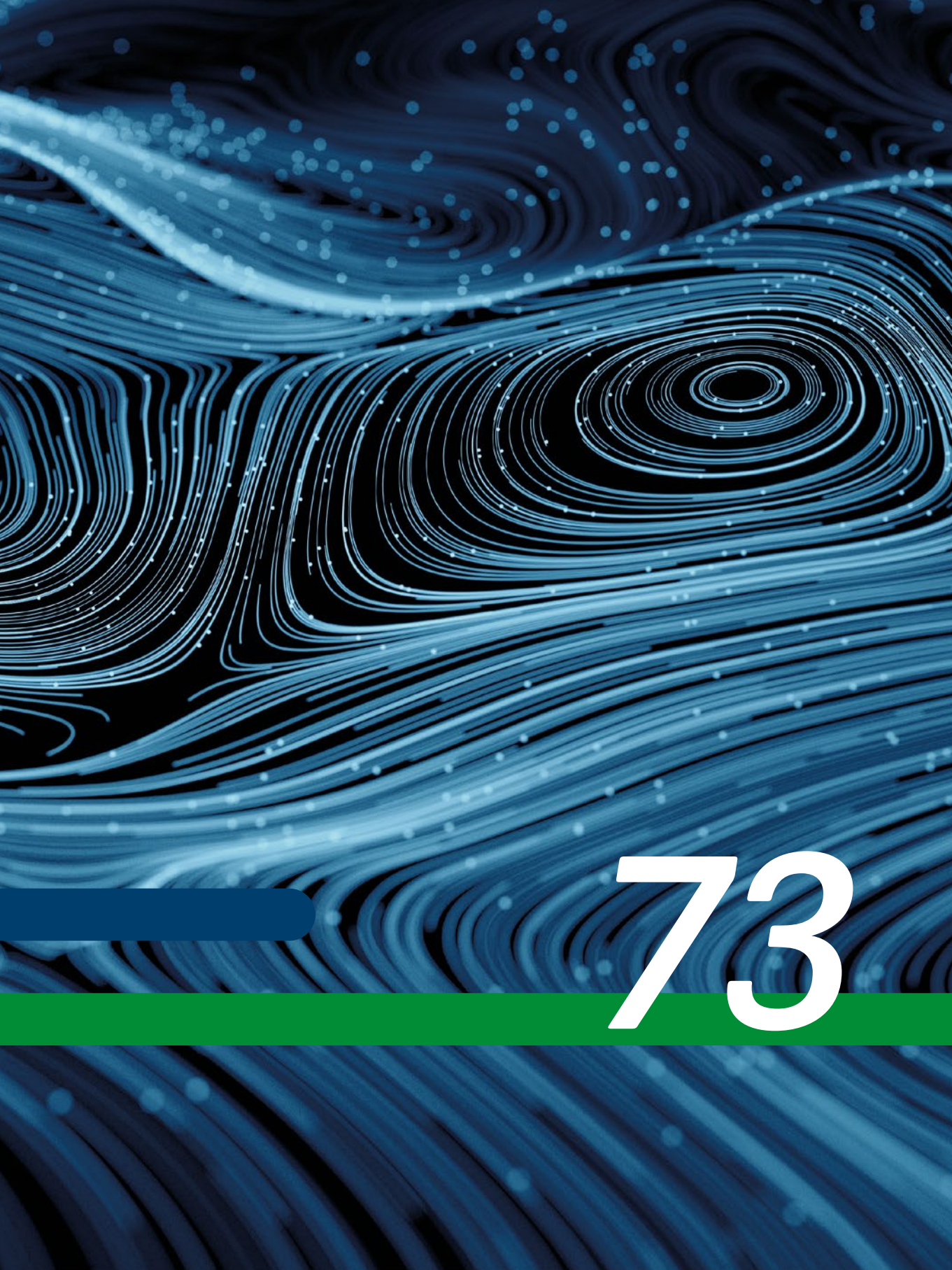
In New Zealand, existing law allows only humans to dispense personalised financial advice. *Globally, there is a growing trend of AI based financial advisors, also known as robo-advice. Robo-advisors provide consumers with personalised investment, insurance, lending and retirement advice. Current law is stifling local innovation in this sector. In 2017, New Zealand banks made submissions to the Financial Markets Authority (FMA) showing strong support for an exemption to the law which would enable robo-financial advisors.*

The FMA responded that an exemption has the potential to improve consumer access to advice in a cost effective and innovative manner. Any exemption would need conditions in place to help address the risks and provide consumer protection safeguards, it said. After a consultation process, the FMA announced it will provide exceptions and authorise robo-advice from early 2018.

[65] How to Regulate Artificial Intelligence. Allen Institute for Artificial Intelligence, Oren Etzioni. New York Times, September 2017.

PART FOUR:

Where to from here?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PART FOUR: Where to From Here?
The Opportunities and Challenges of AI for New Zealand

Determining the Opportunities

Research participants shared their opinions on potential outcomes and benefits of AI use in New Zealand, including expected stages of deployment. One participant stated that AI opportunities need to be approached from a "solution-to-a-problem" viewpoint, enabling businesses and communities to realise that some of the major risks or roadblocks to a prosperous New Zealand can be approached using a data driven solution approach. Benefits and pitfalls can then be actively debated.

Initially, AI is expected to be deployed where there are already usable datasets and in sectors that already have high levels of technology use. It is expected that most AI deployment in New Zealand will be software based machine learning for very specific, narrow outcomes. For example, sectors that have already deployed the Internet of Things (IoT) solutions, are well positioned to adopt AI to maximise the value of their data.

AI is also expected to be deployed in sectors that are dependent on legal or regulatory review. A good example is 'robo-advice' where large amounts of financial data can be analysed for the provision of personalised financial advice.

For sectors that are typically slow to change and have a lower penetration of technology, AI will be deployed at a slower rate. However, even in these sectors, we can expect to see AI solutions developed and deployed by new participants. For example in healthcare, while it is expected to be some time before state funded health services rely heavily on AI, we do expect to see new and interesting private or semi-funded services being developed targeting specific health challenges such as diabetes, or faster and cheaper access to health advice, often leveraging an explosion of new private health data sources.

The accessibility and usability of comprehensive datasets **will determine whether a particular sector is ready for AI.**

In healthcare and other social services, a certain level of social licence will need to be developed before the population at large are comfortable with AI driven services. At the same time, most AI will remain invisible to most consumers, in the way that AI for current online searches and maps is.

Advanced robotic AI systems, such as Nanny Robots or Personal Robotic Assistants are not expected to become mainstream for quite some time. Living with a robot will require a significant social licence gained through other successful AI deployments, before the average citizen will be comfortable with it.

Opportunities for Government

AI is set to revolutionise public service delivery. It can improve the efficiency of Government services, tackle large social issues like poverty, inequality, the environment and potentially increase citizens' standard of living.

Adoption of AI in New Zealand Government is currently disconnected and sparsely deployed. There are teams working with data to improve service delivery across several agencies including Statistics, Inland Revenue, NZTA and the new Social Investment Agency.

However, as with many emerging technologies there is a lack of centralised coordination of application and capability development across Government.

Recent progressive work by the Service Innovation Team ("LabPlus")[66] at the Department of Internal Affairs to support a more integrated approach to service delivery across Government has been developing some general principles on how AI could be applied to help achieve the goal of "Government as a Platform" (GaaP), including:

- Policy, legislation, models and other operating "rules" of government should be publicly programmatically available as a necessary precondition for greater traceability and accountability in the applied use of the rules.
- Algorithmic transparency and ethics should be deeply considered in the design and delivery of all publicly funded use of AI to ensure systemic biases or normative outcomes are not projected onto end users.
- The use of personal AIs as a legitimate and short term channel for service delivery working with programmatic interfaces (APIs).
- Leveraging and contributing to an AI commons rather than building bespoke or siloed infrastructure.

A 2017 analysis by Oxford Insights[67] ranked New Zealand in 9th position among the 35 OECD countries for Government AI Readiness. This includes public service reform, digitalisation, the economy, skills and underlying digital infrastructure.

New Zealand performed best in Digital Public Services and Government Effectiveness (ranking 4th in both areas across the 35 countries analysed). However, New Zealand's score was tempered by low ranking in Innovation (19th) and the number of AI Startups (27th). Despite high scores in Data Quality (5th) and Data Capability (6th) a lower score was found in Data Availability (12th) due to the closed nature of most government data. Although still above the OECD average, more open data would benefit New Zealand AI adoption considerably. In 2017 the roles of the Government Chief Data Steward, and the Government Chief Digital Officer were created. They work in partnership to facilitate government agencies to build their capability and manage the data they hold as a valuable strategic asset. The GCDS is also tasked with accelerating the release of open government data.

New Zealand's Government is the 9th best prepared in the OECD for the looming artificial intelligence (AI) revolution. The index measures nine metrics, ranging from in-country digital skills and government innovation to existing data capabilities.

Source: Oxford Insights, Govt AI Readiness Index, 2017.

> *"Artificial intelligence systems are built on data. Therefore the quality and availability of data and the ability of a government to work with it effectively are critical."*
>
> **OECD 2017**

Given AI can analyse large datasets surrounding particular issues, this will enable Government to tackle issues that in the past, have been difficult to approach from an evidence based perspective. Our research participants raised a variety of compelling use cases:

[66] LabPlus, What's Next? Digital.govt.nz, August 2017.
[67] Government AI Readiness Index. Oxford Insights, December 2017.

- reducing child abuse, substance abuse and problem gambling.
- identifying, measuring and addressing underlying causes of inequality.
- reducing traffic congestion through improved information services, traffic light management and roadworks planning.
- optimising usage and safety of existing roads, rather than building more roads.
- accelerating the adoption of autonomous vehicles on New Zealand roads to reduce accident rates.
- improved healthcare through better insights from patient medical and environmental data, precision medicine and more targeted, personalised treatment plans.
- reduction in health costs through better scheduling and optimisation of health assets and workforce.
- improved earthquake prediction models.
- improved environmental management such as energy reduction.[68]
- affordable housing from construction sector efficiencies.
- acceleration of the Walking Access Mapping System (WAMS) through textual analysis of digitised property titles.

FITTING MORE CARGO INTO FEWER SHIPS

Kotahi, a supply chain collaborator, works with more than 40 exporters, importers and logistics partners to plan, source and deliver shipping container capacity for New Zealand exports. *Nearly one third of those exports are perishable, so timing and accurately matching available container space to demand are critical to success.*

"We've gone from zero to just under 50 percent of all of New Zealand's containerized exports going through our platform within the space of six years" says Neville Richardson, Group IT Manager at Kotahi.

Kotahi have replaced their previous manually operated spreadsheet based demand forecasting tool with an automated solution using Microsoft Cortana Intelligence technologies. This helps increase accuracy and improve Kotahi's ability to choose the right size container ships, at the right times and dispatch them to the right ports.

The previous system was approximately 80 percent accurate, but it required four days every month from highly skilled employees who were familiar with complex manual forecasting models. Data scientists helped to build Kotahi's new demand forecasting application as an Azure Machine Learning web service that forecasts using a multiple level hierarchy.

"We chose one of the time series models in Azure Machine Learning that forecasts on a multi level hierarchy," says Vanja Paunic, Data Scientist at Microsoft.

"Kotahi's shipping orders are aggregated into multiple levels, including by customer, by destination, by commodity, by container, and so on. The machine learning model successfully generates a consistent forecast over these multiple levels."

[68] cf. Deepmind AI reduces Google Data Centre Cooling Bill by 40%, 2016.

Opportunities for New Zealand Businesses

There are a myriad of ways that businesses are using AI, yet they fall broadly into two categories: to improve the productivity or competitiveness of the business, or developing new products and services.

Improving Productivity

According to the OECD's 2017 Economic Survey,[69] New Zealand continues to have low labour productivity compared to other OECD countries. Part of the answer to increasing our overall productivity is to improve efficiency using technology, including AI systems. Some examples include:

Robotic Process Automation: Large enterprises often contain large administration teams. These roles usually involve repetitive manual data tasks, transferring data from one system to another. The branch of AI known as Robotic Process Automation (RPA) enables machines to learn how to do repetitive clerical roles, which will no longer be prone to human error nor reliant on people in the office.

Predictive Modelling: There are opportunities in many sectors, to reduce waste and improve quality by using predictive modelling and just-in-time logistics. This is particularly critical in the food industry where produce is perishable.

Enhancing Customer Experiences

AI can communicate with customers faster and more accurately than humans. AI can also work all hours, does not require a desk, lights or an airconditioned office!

Intelligent Customer Service

For customers, AI based customer service means no more 'hold' music or waiting for a customer service agent to become available. For example, China Merchant Bank's customer service bot handles a staggering 1.5 million or more customer conversations per day[70].

[69] Economic Survey of New Zealand 2017. OECD, June 2017.

[70] How Artificial Intelligence is Transforming Enterprise Customer Service. Forbes.com, February 2017.

Self-service AI agents are always available immediately and are often more accurate and consistent in their responses than a human. They can be trained to always respond to emotion in the optimal way, plus they never tire or experience a bad mood themselves.

Personalised Experiences

AI can successfully create uniquely personalised experiences. For example, the support offered to someone who has successfully applied for their first credit card would be a different offering for someone who has held credit cards before.

Doing the Work for You

Customers can simply tell the AI in plain language what they want to do and recommendations will be made. For example, Martin the wine chatbot from New Zealand company, Wine-Searcher has learnt how to recommend wine selections based on the users description of either grape preference or which food they are pairing the wine with.

Anticipation

Most of us are familiar with recommendation systems that suggest content we might like to view, books to read or products to buy. For example, Amazon was recently granted a patent[71] for 'anticipatory shipping' where products are shipped closer to customers before they even place an order.

Opportunities for AI Export

The New Zealand tech sector is the country's fastest growing sector and third largest exporter[72]. There is a clear opportunity for the sector to develop AI based technology and export it. New Zealand AI based businesses currently include Soul Machines, Dexibit, Weta Digital, Imagr, FaceMe, Ohmio Automation, Performance Lab, Textferret and Xtracta.

Historically, New Zealanders have been early tech adopters and our nation is considered by many international firms as a good early test market. While technology needs to be tested at scale, New Zealand's size, timezone and geographical isolation enables more controlled testing at early stages of a product's lifecycle.

A key driver for encouraging and supporting AI exports is the increasingly critical nature of technology businesses. Six of the world's 10 most valuable companies are now technology firms. These international giants are rapidly commercialising AI technologies and making their AI cloud services, APIs and open source frameworks readily available to application developers worldwide. This creates opportunity for local firms to build upon these global scale platforms to develop solutions for world markets.

LEARNING INVOICE CODING BEHAVIOURS

Founded in 2006 in Wellington, New Zealand, Xero provides online accounting software for small businesses around the world. In March 2017 Xero launched a pilot program that uses AI to code invoices for its customers. Using machine learning, the program can learn the individual invoice coding behaviours for all of Xero's customers. Previously, users entered account codes manually, which was time consuming and prone to errors (Xero found over 3 million common mistakes in their Find and Recode data). The new AI model is 80% accurate after only four invoices, and becomes more accurate with further training.

Users enter over half a million bills into Xero's system daily so Xero launched the same AI based program for its bills feature in October 2017. The AI system will only start suggesting codes once businesses have 150 approved bills, and is currently 70-75% accurate on average for supplier bills.

[71] Method and system for anticipatory package shipping. United States Patent US8615473, December 2013.
[72] Digital Nation New Zealand: From a tech sector to a digital nation. NZTech, July 2016.

Barriers and Challenges to AI Adoption in New Zealand

Lack of Understanding

While many New Zealand decision makers are aware that AI will have transformative effects, 78% of organisations surveyed said that a key barrier inhibiting its deployment is that parts of the business do not understand AI or its potential. Just 36% said their company's board is discussing AI and 58% said this is happening at executive level.

Polarising views and a lack of visible case studies are key sources of this barrier. Extreme views of AI are inhibiting businesses from discovering how AI could benefit them. Media representations still focus on a dystopian worldview of superintelligent robots intent on ruling people.

The most visible forms of AI are 'personified' conversational interfaces; smartphone assistants, basic chatbots or avatars.

However, when AI is well deployed, it usually becomes invisible. No one explicitly considers recommendations from Amazon or Netflix as AI, yet machine learning algorithms power these systems. Most people use or interact with AI every day, but seldom recognise it. 'Headless', or non-personified AI is still intangible to most people.

> *"However, when AI is well deployed, it usually becomes invisible."*

Polarising Debate Continues

Debate regarding the implications of AI as a malevolent superintelligence continues, spearheaded by public figures such as Elon Musk, Stephen Hawking and Mark Zuckerberg. Musk argues that AI is a "fundamental existential risk for human civilisation. Once there is awareness, people will be extremely afraid." Zuckerberg counters that Musk's predictions are irresponsible. This debate could have a positive result, by instigating discussion between Governments and the private sector. However, our research suggests that current public debate is continuing to mystify AI, rather than develop greater understanding.

Just 36% of organisations surveyed said their company's board is discussing AI

A Pragmatic Approach

If we are to remain internationally competitive, it is important that New Zealand business leaders are encouraged to learn more about AI and the value it could bring to their business.

Decision makers need to gain a better understanding of:

- what does AI mean in a business context? What benefits can it bring?
- what are the implications of AI use in a business context?
- what legislation or regulation affects our AI? What social impacts do we need to consider?
- what are the competitive threats from AI? Do we understand the impacts of AI to our competitors?
- what are the specific opportunities in business strategy and digital transformation strategy?
- is our business ready to adopt AI? Do we have lean processes, do we have the right data?
- how do I navigate the ethical considerations of AI?
- who in my organisation knows about AI? Who should I go to in the market?

Our research participants reported that considering the adoption of AI is a complex business decision, that seems daunting to many. Subsequently, this is delaying the decision making process and potentially strategic adoption of AI in New Zealand business.

Lack of Scale

New Zealand's lack of scale in business and investment is also inhibiting our ability to adopt AI. Even if businesses have the technical and commercialisation capabilities to realise AI opportunities, New Zealand small or medium sized enterprises (SMEs) struggle to secure capital investment.

New Zealand's smaller population (compared to China's 1.38 billion) also means less localised data is available for AI training purposes. Several senior AI experts suggest it is the quality, not quantity, of training data that delivers successful machine learning outcomes[73]. New Zealand should focus on making accurate localised data sets accessible, to avoid the scenario where we become a net importer of commercial training data sets from overseas.

Risk of Being Too Slow

Fundamentally, organisations need to be digital before implementing AI, producing, collecting and storing business data online. While many New Zealand organisations are on their digital journey, most are still technologically risk averse, which appears to be a factor in slow digitalisation.

> *"The optimistic view might be that what matters is the ability to take advantage of what US or Chinese technology groups create. The pessimistic view is that if one's economy is not in the technology game, it is not in the economic games of the future at all. I suspect that the latter view may be correct."*
>
> **MARTIN WOLF,** Financial Times

> *"New Zealand organisations are tech savvy, willing to experiment. We need to get people to see what AI is and rethink how we do a lot of things. With AI, we can't just assume "she'll be right""*
>
> **AMY FLETCHER,** University of Canterbury

The challenge is that New Zealand organisations are not taking AI, or the competitive pressure that AI will create, seriously. Our research shows that very few businesses are preparing for the world enabled by AI. If organisations do not quickly understand AI and adapt, New Zealand risks falling behind globally. More than with other emerging digital technologies, research participants suggest there is need for forums, support, strategic level conferences and sharing of AI knowledge between organisations. In addition, New Zealand also lacks substantial depth of startup and private investment activity to incubate early stage AI businesses.

AI-DAY 2018

The AI Forum, in partnership with Auckland company NewZealand.ai, hosted New Zealand's largest AI conference AI-DAY in March 2018. 500 attendees came together to hear from international and local speakers, learn about AI applications and network with other Kiwis working with AI. The next annual AI-DAY event will be held on 28 March, 2019.

[73] http://newscenter.lbl.gov/2018/02/21/new-berkeley-lab-algorithms-create-minimalist-machine-learning-that-analyzes-images-from-very-little-information/

Other Challenges in Adopting AI

Further challenges, raised by research participants include:

Practical Use Cases. 48% of survey respondents said a key barrier to AI adoption is a lack of clear business cases. Practical use cases need to be developed so technology can be quickly applied. The issue may be more of visibility and celebration of case studies rather than a lack of commercial application. In some cases, this is because successful AI is seemingly invisible.

Education. 44% of survey respondents considered education a key barrier to AI adoption. Specifically, traditional education providers are not yet providing the skills and training required to develop AI excellence in New Zealand. However, there are growing opportunities for businesses to tentatively experiment with freely available online Machine Learning tools[74] and openly available online training programmes.[75]

Data Issues. 38% of research respondents considered data issues are too severe, either poor quality data or lack of data and systems integration. For example, farmers could use AI extensively to predict pasture or fruit growth, to produce higher quality milk, or better beef cows. However, the training data for farms is climate and local pest dependent.

Copyright Law. A recent report from Deloitte[76] found that New Zealand Copyright law does not permit:

- data mining; the technological analysis of copyright materials for patterns, trends, and uses other than their intended purpose.
- machine and artificial intelligence which relies on the ability to access large amounts of data for non-consumptive uses, to train algorithms by trial and error.
- software that matched the audio stream of a television program against a database to inform the user what program they were watching.
- a commercial database which provided information to lawyers on how other litigators had framed successful arguments on particular legal issues in court.

Text and data mining (TDM) technologies support automated searches to identify patterns, trends and other useful information. They are transforming research, but the absence of an exception for text and data mining is arguably placing New Zealanders at a competitive disadvantage, compared with other jurisdictions.

Privacy, Security and Criminal use. While there is a risk that AI can be used criminally to manipulate society, this is not yet quantified. However, 40% of respondents during this research project indicated that privacy and security of data as a key barrier to uptake of AI.

Defence and Military use. Additionally, military and defence organisations around the world – and non-state actors – are heavily investing in AI weapons research. Digital security ("cyberattacks", particularly as the private sector controls much of New Zealand's critical infrastructure) and political security (social media manipulation, extremism and radicalisation) raise additional concerns for New Zealand. Policy makers must rapidly develop awareness of the potential implications of malicious AI use. A February 2018 report led by the Future of Humanity Institute[77] surveys the landscape of potential security threats from malicious uses of AI and proposes ways to better forecast, prevent, and mitigate these threats. The question remains open as to what the long-term equilibrium between attackers and defenders will be. New Zealand's national cybersecurity strategy must clearly evolve to strongly feature responses to AI threats, including the deployment of AI for defence purposes.

[74] https://www.blog.google/topics/google-cloud/cloud-automl-making-ai-accessible-every-business/

[75] https://www.coursera.org/learn/machine-learning/lecture/zcAuT/welcome-to-machine-learning and https://www.blog.google/topics/machine-learning/learn-google-ai-making-ml-education-available-everyone/

[76] Copyright in the Digital Age: an economic assessment of fair use in New Zealand, Deloitte 2018.

[77] The Malicious Use of Artificial Intelligence – Forecasting, Prevention, and Mitigation, Future of Humanity Institute et al, February 2018.

Recommendations

Overall, the AI Forum's aim is for New Zealand to foster an environment where AI delivers inclusive benefits for the entire country. Report recommendations are collated within these six themes; coordinated strategy development, creating awareness, assisting AI adoption, increasing data availability, growing the talent pool and adapting law, ethics and society.

Theme 1: Forging a coordinated New Zealand AI strategy

Recommendations

1.1 Develop a coordinated national AI strategy as part of New Zealand's Digital Strategy

New Zealand needs a coordinated strategic approach to AI to maximize the benefits of AI for the whole population, prepare us for foreseeable effects on society and enable an effective response to AI investment by international businesses, governments and military organisations.

AI should be a core pillar of New Zealand's Digital Strategy, facilitating an integrated approach to AI and the adjacent data sciences. New Zealand also needs to nurture a vibrant, well connected ecosystem of AI developers, researchers, private sector and the Government. Public AI investments should be coordinated across the AI value chain, from funding pure research and maximizing data availability to accelerating Government AI adoption and seizing innovative approaches to grow the talent pool. Increased private AI investment should be encouraged and facilitated through greater availability of AI focused capital, effective sharing of best practices, investment cases and increasing AI knowledge among company directors and managers.

Key actions

- **1.1.1 Coordinate AI research investment across institutions.** A coordinated national structure should be considered to bring adhoc university research teams closer together. Consideration should be given to leveraging the Centres of Research Excellence (CoRE) model of inter-institutional research networks, with researchers collaborating on commonly agreed work programmes for downstream commercialisation. This would also provide an opportunity to collaborate with other international centres of AI excellence to increase the research scale and effectiveness.
- **1.1.2 Coordinate use of AI in Government service delivery.** The Government is well positioned to drive awareness and knowledge by using AI to improve its own service delivery. This is an important step in helping to reduce the current digital divide, particularly with regards to access to education and health. AI could help deliver better social outcomes, support the design of evidence-based policies, increase the efficiency of Government operations and benefit taxpayers. The newly established role of New Zealand's Chief Technology Officer (CTO) should champion the use of AI throughout the public sector and ensure a coordinated cross-agency approach, leveraging the progressive work being done by DIA's Service Innovation Team ("LabPlus") in particular.
- **1.1.3 Increase private sector AI investment.** Although there are Government incentives to encourage R&D in the private sector, specialist corporate AI investment vehicles, seed funds, angel investment and venture capital funds will be required to stimulate AI commercialisation at scale in New Zealand. A continued warming of sentiment towards intangible technology-based investments will be needed, together with ongoing attraction of appropriate capital sources from overseas.
- **1.1.4 Increase international participation.** New Zealand needs to continue building direct links with leading overseas research institutions and commercial organisations to accelerate capability growth. New Zealand researchers and developers should be facilitated to collaborate directly with more international partners.

1.2 Ensure AI features strongly in the national cybersecurity strategy

As the New Zealand Cyber Security Strategy and Action Plan is reviewed, a focus should be placed on the implications of weaponised AI software, the potential damage it could cause to national infrastructure, New Zealand's sovereignty and options for using AI technologies for protection.

Theme 2: Creating Awareness and Understanding of AI

Recommendations

2.1 Advance AI Awareness and Understanding

New Zealand needs to significantly advance mainstream AI awareness by facilitating broad discussion on its themes and impacts. This will help reduce the negative impact of sensational media coverage and popular culture, particularly on the topic of employment and jobs. Public and private enterprise need to gain a better understanding of what is possible and how to evaluate AI. The AI Forum is now positioned to be a 'centre of gravity' to facilitate these conversations throughout the country.

Key actions

- **2.1.1 Facilitate pragmatic AI dialogue to demystify AI.** New Zealand needs to create greater public awareness of AI and how it can benefit society. Narratives should be developed highlighting how AI can complement, rather than replace human skills. The development of pragmatic case studies will also assist organisations in better understanding and evaluating opportunities.
- **2.1.2 Undertake further AI impacts research.** Deeper research into the impacts of AI on the New Zealand economy and society is required to facilitate continued constructive debate.

Theme 3: Assisting AI Adoption

Recommendations

3.1 Develop 'how to' best practice resources for industry and Government

Working groups should be established as a central point of knowledge for creating 'how to' guides and investment case templates for AI adoption across sectors. Deliverables will consider business and technology objectives, but also guide in the areas of law, policy and understanding societal impacts. The AI Forum is centrally positioned and could provide independent facilitation of these working groups.

Key action

- **3.1.1 Create and share best practice resources.** Once produced, best practices should be widely distributed to New Zealand organisations for their reuse. For example, AI investment case templates, AI portfolio management tools, AI case studies and AI governance terms of reference.

3.2 Accelerate enterprise AI deployment

New Zealand needs to encourage larger businesses to adopt AI at a faster rate, compressing time cycles for returns on investment (ROI). Proactive engagement of large enterprise will be needed to accelerate decision making cycles for faster AI adoption, including better connections of tech leaders across enterprise. This can be achieved through awareness raising activities, additional research demonstrating ROIs and best practice pathways.

Key action

- **3.2.1 Educate directors and executives.** A key finding of this report is the low levels of AI awareness at board level and, to a lesser degree, among senior management. A national programme of director and executive education should be established to deepen understanding to enable boards and managers to approach AI investments with more confidence. Furthermore, company Board compositions should increase representation from technology leaders able to more clearly articulate the implications of AI for business.

3.3 Support SME adoption of AI

AI should be included as an extension of the work Government is engaged in to encourage SMEs to use digital services. For SMEs, these will be business, not technical conversations. Ideally, SMEs should understand the application of AI to aid businesses productivity. Local and Regional Economic Development Agencies (EDAs) could coordinate nationally to deliver these outcomes.

Key action

- **3.3.1 SME AI training.** Working in coordination with EDAs to deliver training and education aimed at enabling SMEs to understand the opportunities to use AI in their business, which products are available and who to contact to progress to implementation.

3.4 Support AI startups and exporters

Through the Government's current investments in accelerators and incubators, a dedicated focus should be made to encourage AI startups. This could be achieved by initiating and supporting specific AI accelerator programs aligned with key sectors such as AgriTech, FinTech, HealthTech or EdTech. Organisations such as Callaghan and NZTE should expand existing support programmes for New Zealand AI businesses exporting overseas.

Theme 4: Increasing Trusted Data Accessibility

AI, as with the adjacent data sciences, is dependent upon the ready – and trusted – availability of high quality, accessible data. As recognised by the Data Futures Partnership there are huge economic, social and environmental opportunities from treating our data as a national strategic asset and using AI to realise the value contained therein.

4.1 Increase data availability and accessibility

Currently, most data collected by Government agencies is not openly published, despite long held principles requiring its release[78]. In 2017 the Chief Executive of Statistics New Zealand was designated as Government Chief Data Steward. The purpose of this role is to facilitate government agencies to manage the data they hold as a valuable strategic asset. This includes accelerating the release of open government data. Accessible data is essential for AI to deliver successful outcomes.

Key actions

- **4.1.1 Release public data**. The Government should be encouraged to continue its efforts to ensure all public data is released, including specific investigations of particular datasets.

- **4.1.2 Publish localised data repositories.** New Zealand's smaller scale may make it difficult to find and use local AI data training sets so developing one or more data repositories will improve the accessibility of local training data sets that are uniquely Kiwi, instead of relying on overseas data sets.
- **4.1.3 Investigate 'data trusts'.** New Zealand should investigate the creation of 'data trusts'; frameworks and agreements to ensure the safe, trusted and efficient exchange of data between between public and private sector organisations to enable AI-based solutions.

Theme 5: Growing the AI Talent Pool

Recommendations

5.1 Increase the supply of AI talent

There is both a strong global demand for AI specialists (including machine learning experts and data scientists) and an increasing supply shortage. While universities need to offer more courses and degrees in this field, we also need to encourage the choice of AI related fields as a career. To meet the short term demand it is recommended that alternatives such as Massive Open Online Courses (MOOCs) be considered as viable options. Running a pilot between NZQA and a MOOCs provider to enable nationally recognised AI qualifications endorsed by industry could also help bridge the short term supply gap.

Key actions

- **5.1.1 Increase AI courses, degrees, student and researcher numbers.** New Zealand's universities need to continue to develop their AI-related degree courses and increase the number of students

[78] Declaration on Open and Transparent Government. New Zealand Government's Cabinet Approval. August 2011.

choosing to take these subjects. Increasing the numbers of masters students, PhDs and specialist researchers is also an important action for the sustainability of New Zealand's AI ecosystem.

- **5.1.2 Ensure appropriate immigration skills settings.** Immigration New Zealand should ensure that in-demand AI and data science skills, including machine learning and machine vision are clearly included on the long term skills shortage list.
- **5.1.3 Attract international talent.** New Zealand's international profile needs to be increased, highlighting our nation as a place where AI talent wants to live and work. For example, in 2017 the LookSee Wellington campaign offered to bring 100 of the brightest tech talent to New Zealand for job interviews with 45 participating firms. This campaign generated international interest with 1.6 million people visiting the website and 48,000 applying for 100 places. A similar initiative could be considered to attract AI talent.
- **5.1.4 Offer an AI pilot in partnership with NZQA and MOOCs**. Implement a pilot to enable New Zealanders at all stages of their career and education to participate in internationally recognised online courses which rapidly increase their practical AI skills to help meet the market demand.

5.2 Encourage AI student diversity

Because of the clear societal impacts of AI, and to mitigate against the risk of introduced bias, it will be vitally important to encourage a diverse range of people into AI courses. New Zealand should pilot a programme to bring AI education to diverse areas such as geographically remote towns and to marae.

Key actions

- **5.2.1 Bring AI to diverse communities.** Develop and implement a pilot programme to deliver AI education to socio-economic diverse communities.
- **5.2.2 Diversity Attraction Campaigns.** Ongoing campaigns to encourage a broader diversity of students into AI-related courses and other studies.

5.3 Teach AI in schools

The new Digital Technologies Curriculum content is now available for all schools to use in their learning programmes[79]. This curricula will need the development of resources, teacher skills and knowledge to enable them to understand and teach AI as part of their digital technologies teaching. In addition, the curriculum should continue emphasising digital literacy, critical thinking and soft skills which will be required in the future.

Key action

- **5.3.1 AI in schools pilot**. Develop and implement a pilot programme to deliver AI education to primary and secondary schools to inform curriculum and teacher development.

Theme 6: Adapting to AI effects on Law, Ethics and Society

Recommendations

6.1 Establish an AI ethics and society working group.

An AI ethics and society working group, should be established to collectively investigate ethical impacts, investigate issues, set guidelines for best practice and publish learnings. This working group should be aligned with other international bodies, particularly The Partnership on AI.

Key action

- **6.1.1 Formalise the role of AI Forum NZ Ethics and Society working groups.** The AI Forum already plays a natural role in this area as an already established, neutrally positioned group of academia, Government and industry stakeholders with formal links to the Partnership on AI.

6.2 Review employment practices, law and obligations

New Zealand needs to prepare its workforce for the impact of AI on jobs in the future. While mass unemployment is not expected as a result of the

[79] http://www.education.govt.nz/news/digital-technologies-and-hangarau-matihiko-curriculum-content-goes-live/

adoption of AI, the OECD has recommended New Zealand considers practices such as unemployment insurance, longer notice periods, expanded training incentives and more guidance or counselling for displaced workers.

Key actions

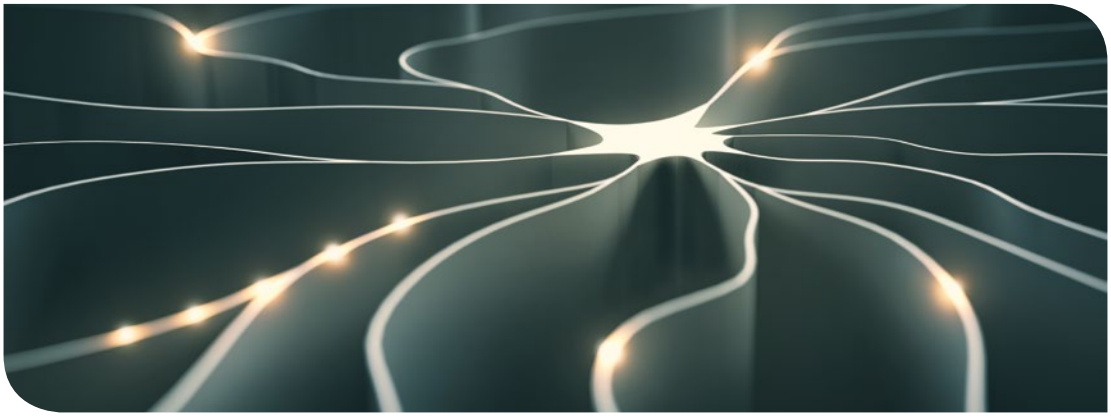
- **6.2.1 Help prepare the workforce for the future.** In the future, AI will lead to changes in job roles, with some disappearing and others created. New Zealanders will need guidance on retraining and upskilling throughout their life. This is also an opportunity for New Zealand to lead education system change towards lifelong learning.
- **6.2.2 Continue to engage with international AI labour policy community.** New Zealand needs to ensure we keep connected and up to date with evolving policy developments. The AI Forum's membership of The Partnership on AI provides a natural interface to both international policy debate and best practice development.

6.3 Review High-Priority Legal Implications of AI

While AI raises many longer term legal implications, there are three high-priority areas identified as part of our research: Reviewing New Zealand's international position relating to autonomous weapons, reviewing the ACC system with regard to potential accidents from autonomous vehicles and reviewing copyright law relating to data use.

Key actions

- **6.3.1 Review New Zealand's position on lethal autonomous weapons.** New Zealand should consider taking a more prominent international leadership role in the current movement to achieve a moratorium and agree an international treaty on lethal autonomous weapons use.
- **6.3.2 Review the ACC system with regard to potential accidents from autonomous vehicles or machines.** New Zealand is in a unique position with its no-fault scheme, the Accident Compensation Corporation (ACC) for injuries caused by accidents. However, we will need to consider novel modern accident scenarios resulting from AI systems and issues of accountability. A cross-sectoral working group should be established to begin discussions, perhaps led by NZ Law Foundation-funded researchers working in this area.
- **6.3.3 Review Copyright Law with respect to potential barriers to data use.** The current review of New Zealand's copyright law should consider flexible exceptions to remove New Zealanders' perceived competitive disadvantage in respect to text and data.



Conclusion

Every day, AI is being increasingly used to make our lives easier and more productive. AI technologies have clearly reached a tipping point of maturity, ready for widespread application across all domains of work and life.

The potential of AI can be found across every facet of society, including business, entertainment, finance, health, manufacturing and more.

In the near future, adoption of AI technologies will be a key driver of change and innovation in New Zealand. Forward thinkers recognise that AI has immense potential to transform companies and the public sector to help solve problems in our society. Improvements to business and public sector services, facilitated by AI will deliver benefits for the entire nation.

There are considerable societal implications of AI, including ethical concerns, detecting bias, accountability and the changing workforce. All of which, New Zealand must address. A key challenge for New Zealand is that there is not enough general AI awareness, including what it can help achieve in business and society, and the risks of not adopting it. New Zealand needs to put in place appropriate structures to help businesses and Government negotiate AI's social and ethical implications.

The Time to Act is Now!

If New Zealand fails to act on the opportunities identified in this report, it will likely lead to increased competitive pressures. If global competitors use AI to reduce the costs of their products or services, make better business decisions and create preferred customer experiences, New Zealand companies risk becoming unviable in the international marketplace. Conversely, companies that adopt AI may well be very successful, both locally and on the world stage.

New Zealand needs to urgently attract AI talent including specialists in mathematics, computer science, data science and the creation of specialised Artificial Intelligence qualifications. Those not specifically working in the tech sector will also need to commit to lifelong learning to be fully engaged as productive members of an increasingly digital nation.

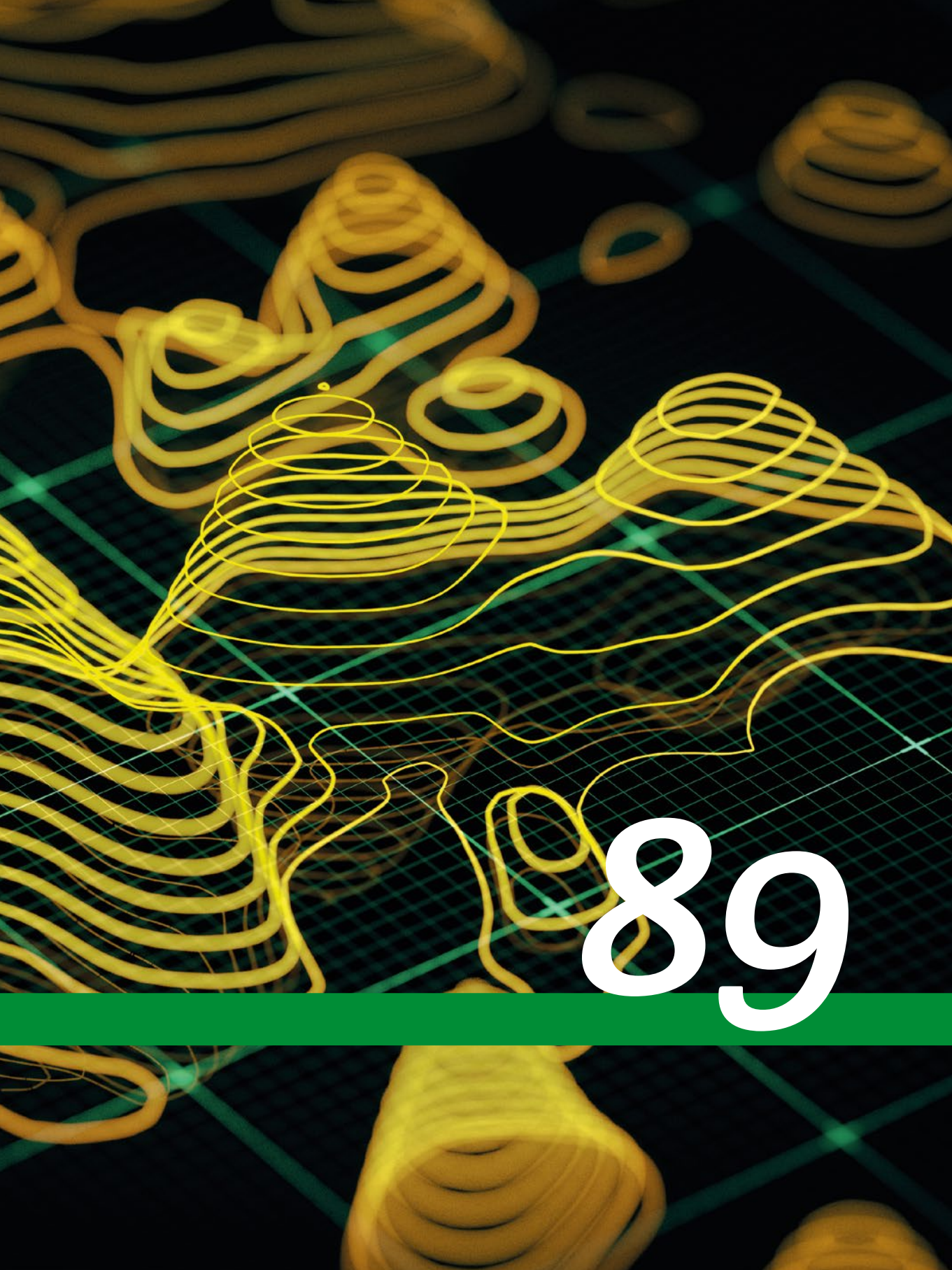
While the outlook for AI to improve New Zealand's economy is positive, it requires a coordinated strategy to ensure New Zealand can effectively and safely invest, deploy and benefit from AI. Our aim is for New Zealand to foster an environment where AI delivers benefits to the entire country.

Ultimately, New Zealand's AI journey is approaching a crossroad, where we either choose to proactively help shape AI's impact on our economy and society, or we passively let AI shape our future lives. ***To shape, or be shaped?***

...we either choose to proactively help shape AI's impact on our economy and society, or we passively let AI shape our future lives. ***To shape, or be shaped?***

APPENDIX:

AI Technologies and Techniques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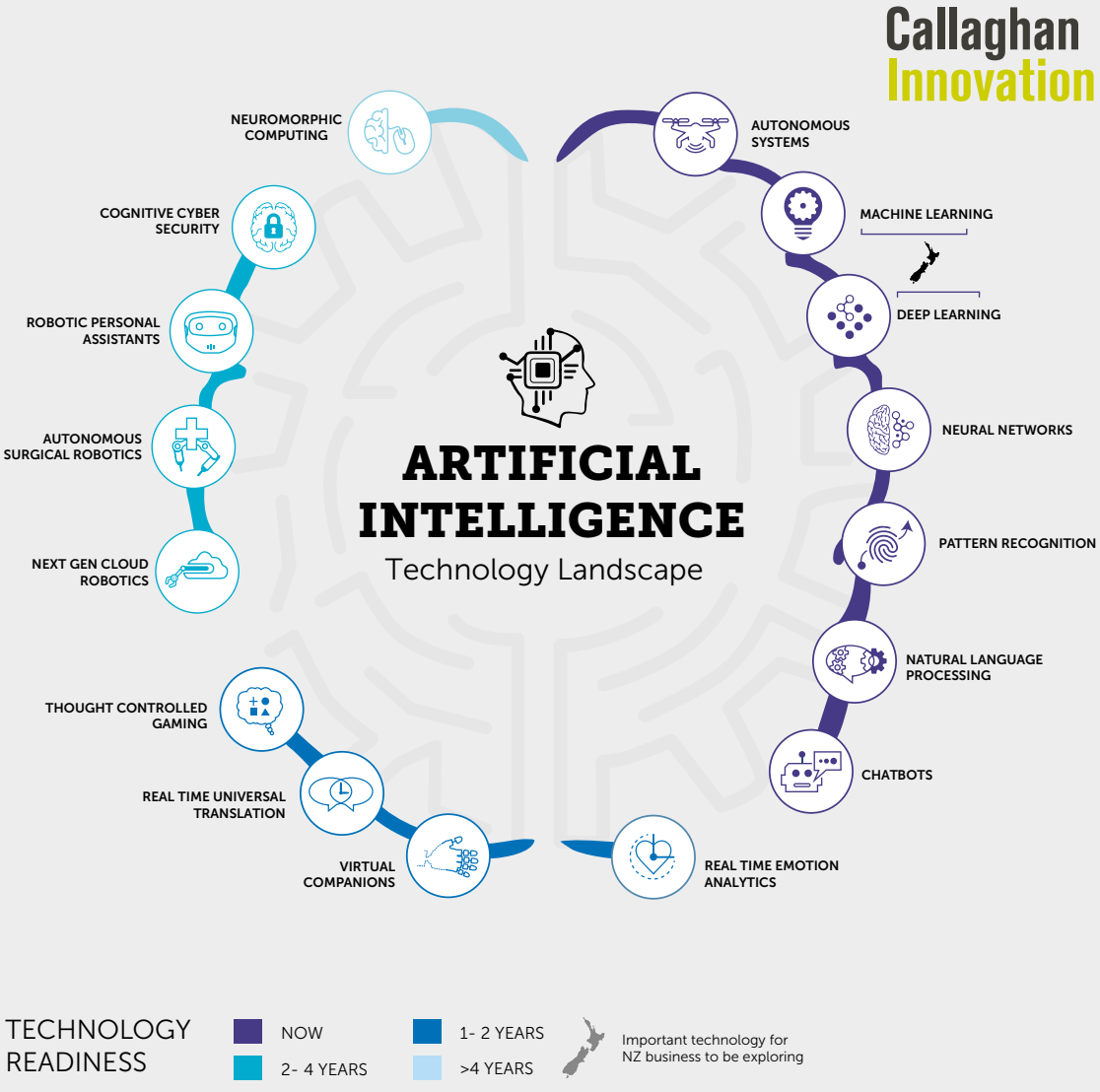
APPENDIX:
AI Technologies and Techniques

As noted in the introduction, AI is a broad family of techniques and technologies which together produce the effect of intelligent, learning, thinking machines. The following infographic has been produced by Callaghan Innovation, New Zealand's innovation agency, to help demystify the types of AI.



Sources: Frost & Sullivan "Artificial Intelligence- R&D and Applications Road Map" (Dec 2016), Harvard Business Review – The competitive landscape for Machine Intelligence (Nov 2016), Shivon Zilis and James Chan "The State of Machine Intelligence, 2016" (2016), Stanford University. "Artificial Intelligence and Life in 2030" (2016), https://en.wikipedia.org/wiki/Artificial_intelligence (2017)

Callaghan Innovation

Artificial Intelligence is computer systems that exhibit human like intelligence. It is a group of science fields and technologies concerned with creating machines take intelligent actions based on inputs.

DEEP LEARNING

A high powered type of machine learning algorithm that uses a cascade of many computing layers. Each layer uses the input from the previous layer as input.

Enabled by neural networks and given big data sets, deep learning algorithms are great at pattern recognition, and enable things like speech recognition, image recognition and natural language processing.

The combination of neural networks (enabled by the cloud), machine learning technology, and massive data sets (the internet), has made deep learning one of the most exciting AI sub-fields recently.

Examples:

Google's DeepMind beating the best human at the game "Go".

THOUGHT CONTROLLED GAMING

The application of AI, wearable technology, and brain computing interface technology to enable seamless interaction with social gaming environments in real-time, through avatars without the need for joystick-type devices.

Examples:

- Emotiv,
- Games Research Lab (Columbia Uni).

REAL TIME UNIVERSAL TRANSLATION

The application of natural language processing to enable two humans (with no common language) to understand each other in real-time.

Examples: Microsoft Translator.

NEUROMORPHIC COMPUTING

Future generation computing hardware that mimics the function of the human brain in silicon chips.

Examples:

- The Human Brain Project
- IBM's TrueNorth processor chip
- NZ's Professor Simon Brown at University of Canterbury

MACHINE LEARNING

Algorithms that can learn from and make predictions on data. Overlaps with Computational Statistics Overlaps with Bayesian Statistics. Underpins Predictive Analytics. Underpins Data-Mining.

Examples:

- Recommender systems (Like NZ's own Movio which recommends movies).
- Xero uses Machine Learning for automated processes (like automated cost-coding).
- JV between Goat Ventures and Minter Ellison for legal AI.

NEXT GEN CLOUD ROBOTICS

Convergence of AI, Big Data, Cloud and the as-a-Service model will enable a cloud based robotic brain that robots can use for high powered intelligent and intuitive collaboration with humans.

Examples:

Cloud Minds.

ROBOTIC PERSONAL ASSISTANTS

Cloud-based AI learns from big data to enable human-like social robots that can perform usefully as personal assistants.

Examples:

Kuka Robotics.

REAL TIME EMOTION ANALYTICS

The application of AI to analyse brain signals, voice and facial expression to detect human emotions.

Examples: Emotiv.

AUTONOMOUS SYSTEMS

Autonomous robots, self-driving vehicles, drones, all enabled by AI.

Examples: HMI Technologies (trial at Christchurch Airport).

NATURAL LANGUAGE PROCESSING

Technologies that enable computer systems to interact seamlessly with human languages.

Includes:

Written language and speech recognition, sentiment analysis, translation, understanding meaning within text/speech, language generation.

Examples:

- Siri, Alexa, Cortana.
- New Zealander Mark Sagar's new company Soul Machines.

COGNITIVE CYBER SECURITY

Cloud-based AI systems trained on historical cyber threat data, capable of mitigating real-time cyber threats.

Examples:

Deep Instinct.

AUTONOMOUS SURGICAL ROBOTICS

Cloud-based AI platforms can help robotic surgeons to perform precise surgeries by learning from large historical surgical data sets (like video).

Examples:

- Imperial College of London
- MIT.

PATTERN RECOGNITION

A branch of machine learning and deep learning which focuses on recognition of patterns in data.

Examples:

DeepFace, (Facebook).

VIRTUAL COMPANIONS

Cloud-connected, virtual reality-based avatars powered by AI engines that can behave and interact just as a human would.

Examples:

Digital companions that provide caregiving companionship for the elderly.

CHATBOTS

A software robot that interacts with humans online, receiving and sending conversational text with the aim of emulating the way a human communicates. An example of natural language processing.

Examples:

- Kiwi start-up Jude.ai (an AI-based financial advisor).
- Kiwi company Wine Searcher.

NEURAL NETWORKS

Computing systems that organise the computing elements in a layered way that is loosely modelled on the human brain. Enables deep learning.

Examples:

- The computing system that sits behind Baby X at Auckland University. New Zealand's
- Professor Kasabov at AUT (Neucube).

Callaghan Innovation

Sources: Frost & Sullivan "Artificial Intelligence- R&D and Applications Road Map" (Dec 2016), Harvard Business Review- The competitive landscape for Machine Intelligence (Nov 2016), Shivon Zilis and James Chan "The State of Machine Intelligence, 2016" (2016), Stanford University. "Artificial Intelligence and Life in 2030" (2016), https://en.wikipedia.org/wiki/Artificial intelligence (2017)

Research Methodology

Our study consisted of two parallels streams of research; market analysis by IDC, including interviews and survey, and an economic impact analysis undertaken by literature review and economic modelling by Sapere.

The specific research methodologies are detailed below.

Market Analysis Methodology

IDC developed the data and observations in this report based on a combination of interviews with experts in the field, a local New Zealand survey and inclusion of New Zealand respondents in an Asia Pacific wide survey. This was complemented with input from international IDC AI research teams, reports and a literature review (consisting of local and international AI news articles, blogs, web pages, white papers, case studies, government reports and other research reports).

Asia Pacific Cognitive/AI Adoption Survey

IDC's 2017 Asia Pacific (excluding Japan) Cognitive/AI Adoption Survey was conducted in June 2017 among organisationss across industries and countries in Asia Pacific. The survey aimed to learn about the current and proposed adoption of cognitive/AI solutions, reasons for adoption and barriers, and the platforms being used. The respondents were either decision makers or members of the decision making team regarding AI and cognitive solutions in their respective organisationss, from IT departments and line-of-business (LOB) functions of companies with 100+ employees. The survey excluded any respondents that indicated they have no intention of adopting AI. There were 50 New Zealand respondents.

New Zealand AI Adoption Survey

A New Zealand focused survey was conducted online and consisted of 20 questions regarding AI knowledge, deployments, impacts, benefits and challenges. The survey was distributed via NZTech, IDC, MBIE's channels and targeted firms considering or using AI. Consequently the respondents are heavily weighted to organisations that are in the more technically advanced sectors including information, media, telecommunications, professional, scientific and financial sectors. The size of firms was evenly distributed with 30% of the respondents having less than 20 employees, 16% more than 5000, and the rest spread between.

New Zealand AI Expert Interviews

IDC met and interviewed 46 active participants in AI in New Zealand including those in academia, tech provider industry, consulting industries and in end user organisations. The respondents were asked to discuss their definition of AI, what they believed the opportunities are for AI in New Zealand, the drivers and inhibitors of AI growth in New Zealand and their recommendations to improve the adoption of AI in New Zealand.

Economic Impact Analysis Methodology

Sapere used a method for estimating the economic value of AI that is similar to that of Accenture[80 81] and is based on one of the economic growth models developed by Hanson[82]. It was assumed that AI represents a new factor of production that can substitute some of the human labour input in each industry, allowing human labour to be reallocated to other tasks and increasing total output. Using this model, over time, the accumulation of an AI 'labour force' increases the rate of economic growth. As mentioned, a crucial assumption is that human labour can and will be reallocated to equally productive tasks when tasks done by humans are shifted to AI 'labour'.

In each industry, we assume that the annual amount of output depends on the combined inputs of general technology, human labour, AI 'labour' and all other

[80] Why Artificial Intelligence is the Future of Growth. Accenture, October 2016.
[81] How AI Boosts Industry Profits and Innovation. Accenture, June 2017.
[82] Economic Growth Given Machine Intelligence. University of California, Berkeley. Hanson, R. January 2001.

$$ln'Y = \frac{ln'A + \rho(1-b)ln'H - b\rho ln'P}{1-\beta-b\rho}$$

types of capital. We assume there are a continuum of job types in each industry, some of which can be done by AI and some of which cannot.

Over time, economic growth in this model occurs via a combination of growth in human labour input, accumulation of computer capital that provides AI 'labour', and accumulation of other types of capital. Following Hanson, the steady-state growth rate in an industry is modelled as:

where:

ln'Y is the growth rate of industry output (the industry's contribution to GDP)

ln'A is the growth rate of general technology in the industry

ln'H is the growth rate of human labour input in the industry

ln'P is the rate of change of the cost of computer technology used to deliver AI services

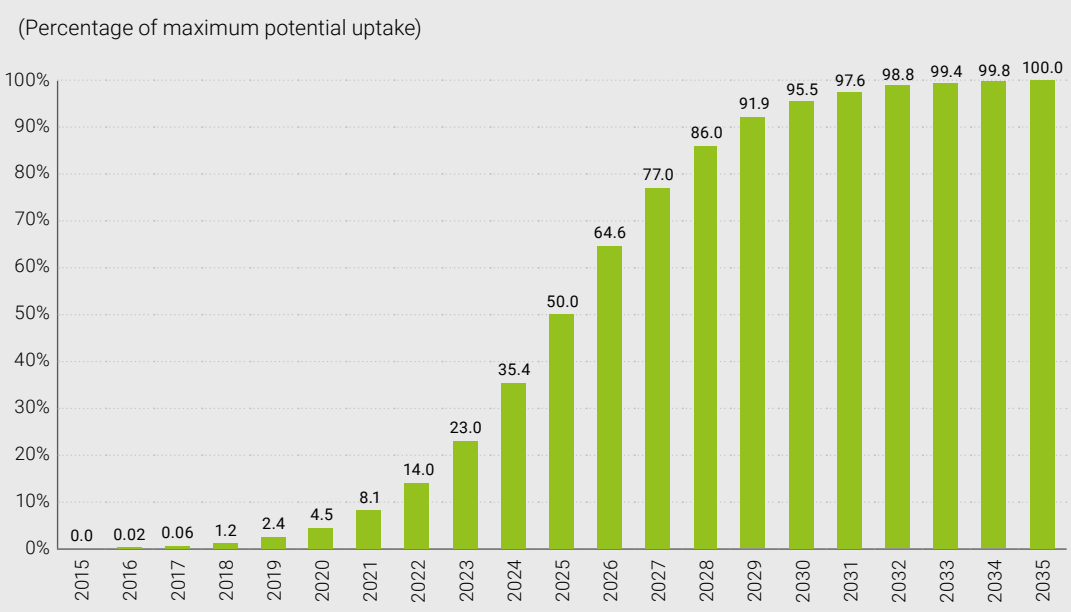
p is the rate of return to labour in the industry (i.e. the relative importance of labour in production);

ß is the rate of return to other capital in the industry (i.e. all capital aside from that used to provide AI inputs); and

b is the proportion of job types in the industry that can be done by AI.

Sapere used this model to estimate two steady state growth rates for each industry, with and without AI. The rate of growth without AI is what arises when *b = 0*. When *b > 0* the model implies a higher steady state growth rate due to augmentation of human labour by AI 'labour' inputs.

Figure 6 – Assumed Adoption Curve for AI Technology



Source: Sapere and Schiff Assumption, 2018

Sapere assume that adoption of AI technology up to the maximum potential level in each industry will take 20 years. They do not attempt to model differential rates of adoption across all industries, and instead assume that adoption in each industry follows a simple 'S' curve (Figure 6). Adoption curves of this type are commonly used to model the uptake of new technologies.

Sapere assume that between 2015 and 2035 the growth rate in each industry gradually transitions from the steady state growth rate without AI to the steady state rate with AI, following the assumed 'S' curve. Using each industry's contribution to GDP in 2015 as the starting point, they were able to produce projections of industry output with and without AI in each year.

As the adoption curve is an approximation, Sapere do not present estimates of the difference in industry output with and without AI in each of the modelled 20 years from 2015 to 2035. Instead they present the difference in industry output with and without AI in 2035 as representative of the difference that AI could make after the technology has had time to mature and be adopted by firms. In this sense Sapere estimates are of the 'size of the prize' of AI, rather than projections of future economic activity in specific industries.

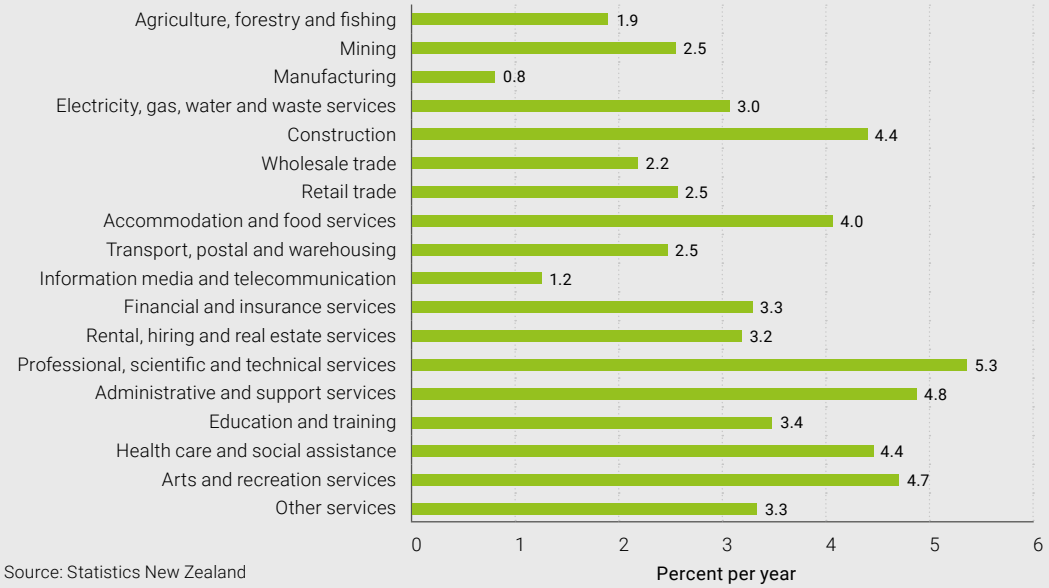
Following this methodology, the impact of AI in an industry in 2015 can be estimated if we have values for the parameters *ln'A, ln'H, ln'P, p, b* and *ß* listed above. The following describes how Sapere estimated these values for each industry.

Growth rate of general technology (ln'A)

This was calibrated for each industry so that the modelled steady state rate of growth without AI technology (i.e. when *b = 0*) is equal to the historic compounding annual growth rate of the industry's contribution to real GDP over the period from 1991 to 2015 (Figure 7). The calibrated growth rates of general technology in each industry are shown in Figure 8.

Figure 7 – Compound Annual Growth Rate of Industry Contribution to GDP

(Real GDP between 1991 and 2015)



Source: Statistics New Zealand

Growth rate of labour input (ln'H)

The growth rate of the total amount of labour input in each industry was assumed to be the same as the historic compounding annual growth rate of labour input in each industry between 1996 and 2015 as measured by Statistics New Zealand's productivity data (Figure 9).

Rate of change of the cost of computer technology (ln'P)

The cost of computer technology used to provide AI services was assumed to decline at a constant rate of 20 per cent per year in all industries. In practice, cost reductions will be achieved by improvements in performance at constant costs, as well as absolute cost reductions.

Returns to labour (p) and returns to other forms of capital (ß)

The rate of return to labour was estimated for each industry from industry level GDP data, based on the compensation of employees as a fraction of total industry contribution to GDP. The rate of return to other forms of capital was initially assumed to be one minus the returns to labour.

Both of these estimated rates of return were then adjusted downwards using a constant 'diminishing returns' assumption, implying that in the long run a doubling of both labour and capital inputs will lead to a less than doubling of output in any industry. The diminishing returns adjustment was set such that the return to labour plus the return to capital add to 0.75 in all industries, and the resulting returns to labour and capital are shown in Figure 10. Such an adjustment is necessary to prevent the modelled steady state growth rates from becoming unrealistically large.

Maximum proportion of tasks that can be done by AI (b)

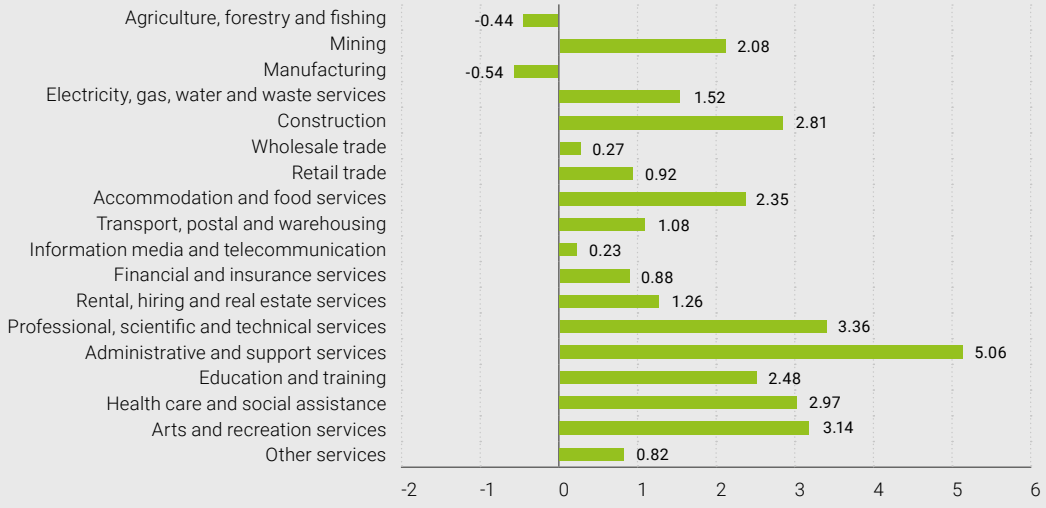
Sapere estimated this proportion by adapting the results of Frey and Osborne[83] to New Zealand. For

Figure 8 – Calibrated Annual Growth Rates of General Technology by Industry

Source: Sapere and Schiff Analysis, 2018

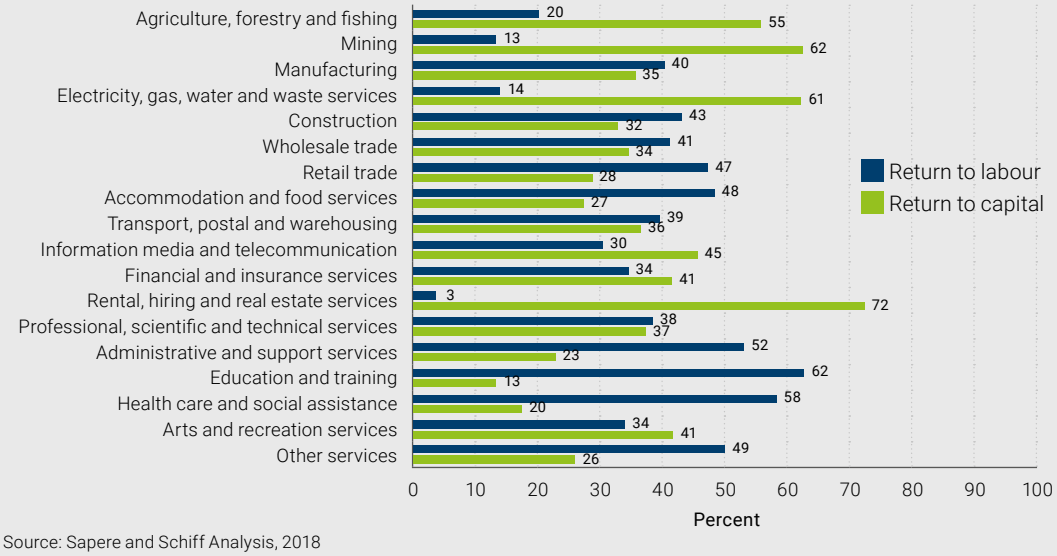
[83] The Future of employment: how susceptible are jobs to computerisation. Frey, C. and Osborne, M. September 2013.

Figure 9 – Annual Rate of Change of Human Labour Input by Industry



Source: Statistics New Zealand

Figure 10 – Estimated Returns to Labour and Capital, by Industry



Source: Sapere and Schiff Analysis, 2018

each industry, they obtained data from Statistics New Zealand on the number of people working in each industry by occupation (2013 Census data). For each occupation, they identified the closest matching occupation type in Frey and Osborne's analysis, and used their corresponding estimate of the probability the occupation could be automated as the proportion of that occupation that could potentially be substituted by AI technologies.

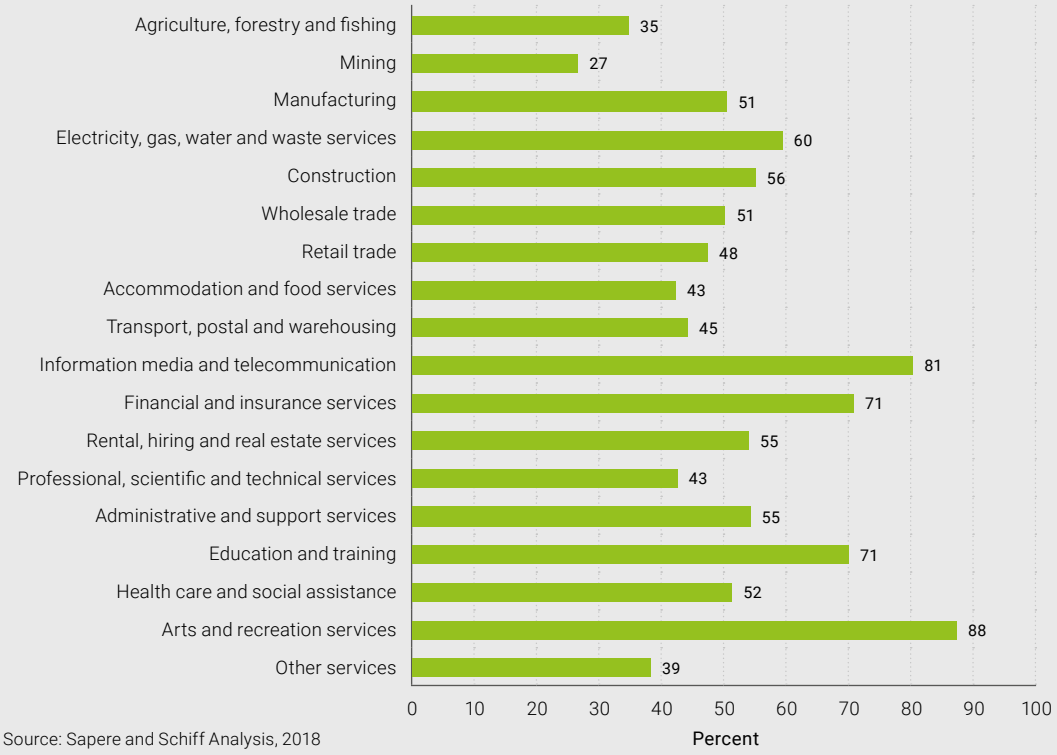
Sapere then adjusted these estimates downwards based on two factors:

1. an assumption about the 'absorptive capacity' of each industry (the incentive and ability of firms in the industry to adopt AI technologies)
2. overall scaling factors reflecting an estimate of the overall potential uptake of AI in New Zealand in low and high uptake scenarios respectively.

Sapere estimated absorptive capacity of each industry using results from Statistics New Zealand's Business Operations Survey. The Business Operations Survey is an annual survey that queries firms behaviour over the past year. The proportion of firms reporting they undertook 'organisational restructuring' was used as an activity to support innovation as a measure of absorptive capacity of AI technology, since adopting AI technology as a substitute for human labour is likely to require significant internal reorganisation.

The proportion of firms that report undertaking organisational restructuring to support innovation

Figure 11 – Estimated Absorptive Capacity of each Industry

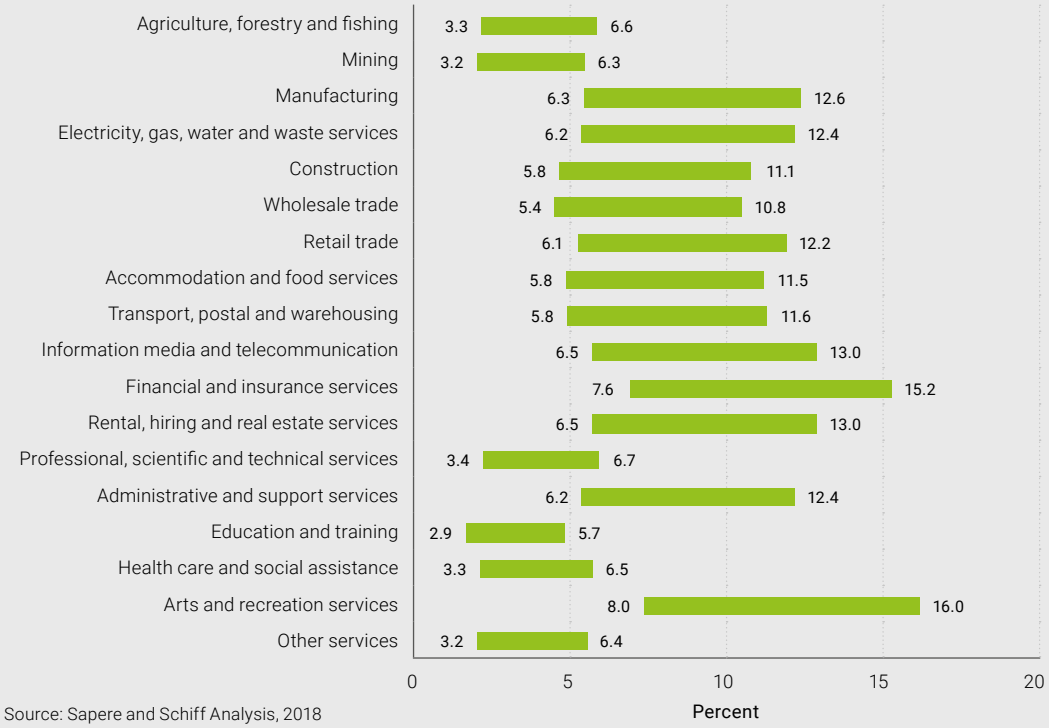


Source: Sapere and Schiff Analysis, 2018

during the past year in the Business Operations Survey is relatively low, typically below 10 percent in any one year. Given that not all firms would undertake the same level of innovative activity each year, the available data was used to estimate how many firms would have done such restructuring during a five year period and this was used as the estimate of absorptive capacity in each industry (Figure 11). The estimated proportion of jobs that could be substituted by AI was multiplied by the estimated absorptive capacity in each industry to determine potential uptake once the incentive and ability of firms to adopt new technology is accounted for.

These estimates were then multiplied by 0.2 in the low AI uptake scenario and 0.4 in the high AI uptake scenario, to arrive at the final estimates of the maximum proportion of the human labour force that can be substituted by AI in each industry (Figure 12). These proportions reflect Sapere's assessment of the realistic overall uptake of potential AI technologies in New Zealand. The range between the low and high estimates is intended to reflect an assessment of the uncertainty associated with these estimates.

Figure 12 – Low and High Estimates of the Maximum Proportion of the Human Labour Force that can be Substituted by AI in Each Industry



Source: Sapere and Schiff Analysis, 2018

The Research Team

The Artificial Intelligence Forum of New Zealand (AIFNZ) aims to raise the level of awareness and capabilities of Artificial Intelligence in New Zealand.

The Forum brings together citizens, business, academia and the Government connecting, promoting and advancing the AI ecosystem to help ensure a thriving New Zealand.

The AI Forum designed, collated and edited the research.

IDC is a premier global provider of market intelligence, advisory services, and events for the information technology, telecommunications and consumer technology markets. More than 1,100 IDC analysts provide global, regional, and local expertise on technology and industry opportunities and trends in over 110 countries worldwide.

IDC conducted the local and international research.

Sapere Research Group is one of the largest expert services firms in Australasia. Sapere provides independent expert testimony, strategic advisory services, data analytics and other advice to Australasia's private sector corporate clients, major law firms, government agencies and regulatory bodies.

Sapere conducted the economic analysis research.

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