The Artificial Intelligence race: will Australia lead or lose?

Mary-Anne Williams

Centre for Artificial Intelligence, University of Technology Sydney, Australia, and

CODEX, Stanford University, USA

E-mail: Mary-Anne@TheMagicLab.org

Abstract

Artificial intelligence (AI) is poised to disrupt humanity, society, industries, local, national and global economies and politics by fundamentally transforming how people perceive, feel, reason and interact with the physical and digital worlds, shaping human experiences, beliefs and choices. The extraordinary potential of AI has created a fiercely competitive race to lead. The prize of leadership, as Vladimir Putin put it, is to shape and control the future for huge benefits and rewards. Some nations are playing hard, jostling for leadership positions. Others, like Australia, are relegated to the sideline, or, worse, have become the playing field where they have little choice but to acquire innovations and technology from AI leaders.

As a nation, Australia simply cannot afford to continue to be an AI adopter and follower, because our economy, our workforce, our national security and our future opportunity is increasingly vulnerable to the influence of AI and the power of those who wield it. Australia's major trading partners have already declared their ambitions to be AI leaders: they are developing strategies, roadmaps and making substantial investments in AI. Australia must urgently set a bold course, develop policies, and take critical strategic action. It must make AI a national priority, identify and mitigate the risks associated with AI, and address the challenges we face in becoming a leader in AI. This paper presents a case and strategies for Australia to aggressively pursue a leadership position in the new AI world order that will unleash significant productivity gains and inclusive economic growth, rather than let other nations and corporations reap the extraordinary rewards at the expense of Australia's national security and future prosperity.

Introduction

Artificial Intelligence (AI) that can enhance, improve and scale human expertise is profoundly changing everything. It is transforming how we perceive and interact with the physical and digital worlds, shaping our human experiences, beliefs and choices. AI technology is increasingly essential for business to compete and prosper in a global economy, as well as for attaining increased productivity and income generation.

Nations that can lead in AI will have the opportunity to shape the future and reap substantial rewards. Recognition of the stra-tegic benefits of AI has led to the so-called AI Race (Lynch, 2019; AI Race 2017). For this paper, it is a race to lead: a multifaceted competition for talent, technology, control, opportunity, productivity, power, profit and prosperity.

The incentives for Australia to seek a leadership position are compelling, as the rewards are exceptionally high, and the and opportunity costs even greater.

The path to leadership in AI, however, is challenging for Australia because as a nation we are a long way behind: our AI capability and capacity is low relative to the current leaders in all areas: universities, industry,

government and civil society. Australia lacks both significant IT manufacturing capability and distinctive AI software offerings. Australians like to believe that Australia *punches above its weight* in a wide range of areas, but there is little independent evidence to suggest that Australia punches above its weight in AI (Australia 2030 Report, 2018). It is critically important for Australia to take a hard look at where the evidence places Australia as a nation in the scientific, engineering and societal aspects of AI. If we are to develop successful strategies that will ensure Australia can develop a leadership position, we must start with a realistic appraisal.

Recently, Infosys determined that Australia was low on AI-maturity (Barbaschow, 2019). However, there is evidence that Australia's aggressive approach to technology adoption (not research, innovation and development) has led to significant investments in digital transformation by individuals, business and government, and as a consequence Australia ranks high on AI preparedness. It stands ready for widespread adoption of AI. This could prove to be advantageous, if Australia can act to fill the gap quickly. However, there is also a significant risk that, without an effective national AI strategy, the opportunity to exploit Australia's preparedness will be seized by AI leaders in other countries with effective national strategies.

This paper presents a case for Australia to urgently make AI a strategic priority and pursue a global leadership position. Not by trying to produce more AI engineers than other countries, but by leveraging our robust political economy, strong legal and policy frameworks, high-quality education and training system, and relatively inclusive society, to avoid the major risks associated with AI, such as safety, security, civil liberty and privacy, and to address the key challenges to achieving AI leadership and productivity.

We first explore AI itself, the advantage it can bring, and the need to lead. We then identify the challenges and Australia's position relative to other key nations. Finally, we describe the risks and provide.

Artificial Intelligence

Artificial intelligence (AI) is a scientific field, a practice, and a capability of human-designed systems and engineered technologies. AI provides a set of methods for reasoning, discovering and recognising patterns, making decisions and taking action.

AI has been described as the new electricity, having the potential to disrupt industries and redefine the nature of business, markets, and government just as electricity began doing more than a century ago (Ng, 2017).

Some of the most successful businesses today are AI companies: Google, Apple, Amazon, Facebook, Microsoft, Alibaba, Tencent, Baidu and WeChat, the, so-called, *Big Nine* companies (Web, 2019), have rapidly scaled their services, and continue to have tremendous impact reshaping business and society in unprecedented ways.

AI technologies can outperform humans in a growing range of tasks. Deep Learning algorithms continue to improve with the volume of training data available, while human performance tends to plateau after a certain level of expertise is attained.

AI offers a wide range of advantages over human intelligence. It can make real-time evidence-based decisions using massive amounts of data; it can scale rapidly and be replicated effortlessly; it is non-judgmental; it can reduce subjectivity in decision making; it can solve complex analytical problems and optimise large scale solutions; it can deliver

services faster, cheaper, and better; it can use behavioural insights to manipulate people at scale; provide mass personalisation services; and recognise patterns in data that humans cannot detect.

The Challenges

Australia cannot produce more computer scientists and engineers than the current AI leaders, the United States and China, but leading in AI requires considerably more than scaling technical expertise.

To lead, Australia must first declare its strategic intent by making AI a national priority. It needs to create the necessary governance focus, economic incentives, and laws and regulations to attract strategic investment and amass AI talent across industry, academia, and the professions.

We cannot ignore the AI race because Australian society, business and our national security are increasingly vulnerable to the power and influence of AI.

Our major trading partners have already declared their ambitions to be AI leaders, taking critical strategic action, and making substantial investments.

Leadership in AI is increasingly important because AI will continue to have unprecedented influence and impact on the Australian and global economies, labour markets, and security. However, AI poses inherent risks and presents significant challenges. Taking a position at the forefront of AI is the best way to mitigate those risks and open up new and exciting opportunities.

Aside from the need to mitigate the risks of AI to attain leadership, there are additional challenges. The challenges have been categorised into four key areas for the purpose of developing actionable strategies.

Governance and Policy: Government influence is weakening, and the profit motive is driving AI developments with little oversight. Self-regulation is non-existent, and reputational risk mitigation is proving to be ineffective even in extreme situations such as live-streamed mass shootings of innocent people. AI impacts both equality and equity. Policy and governance settings determine the level of positive or negative impact.

Power and Access: AI companies are dominating the innovation and technology race. They are accumulating significant market and societal power and controlling access to a wide variety of services without much regard for privacy, diversity or inclusion. There has been a major power shift away from government authority to AI corporations. For example, AI corporations decide what is hate speech and develop specific mechanisms to identify and deal with it, but only in response to crises such as mass shootings. Access to AI services by users, customers, citizens, business, and researchers is not always open, available or accessible. This leads to a wide range of equity and equality.

Responsible AI*:* Australia needs to develop robust design and engineering practices and standards that ensure the development and deployment of responsible AI technologies that are safe, secure, transparent, accountable, fair, explainable, that respect human rights and generate benefits for society.

Education and Training*:* There is a significant global shortage of AI scientists, engineers, and professionals with AI skills in specific domains, ethics, policy, governance, law, business, finance and economics. Australia has not produced or attracted sufficient people skilled in AI to take a leadership position, or even a modestly advantageous

position. Lack of AI capability and capacity has created a major growing bottleneck in the development of AI in Australia. Significant work also needs to be done in the areas of educating for more diversity, inclusion, and access.

Addressing these four challenges is the key to becoming an AI leader. It is critical to note that all four are interrelated and need to be addressed in concert to achieve leadership and reap the productivity rewards. For example, governance and power are two sides of the same coin: mechanisms for oversight create the framework for containing market power. Similarly, AI education should not under-produce or over-produce AI engineers, computer scientists, statisticians, and domain experts required by business and industry as they seek to develop, test and deploy responsible AI systems.

How can we design and deploy Digital ID systems based on principles of data minimization, decentralization, consent, and limited access that reinforce our fundamental rights? How can we govern the surveillance economy where companies track, analyse and capitalize on our clicks and exploit our data without consent?

The Risks

AI is a general purpose technology that comes with major risks as it has the potential to exact significant negative impact on humanity, business, politics, society and the global economy. These risks can be organised into five major categories: economic, privacy, safety, security, and social — see Figure 1.
Economic Risk arises from the automation of work, the impact on labour markets and the economic opportunities that AI generates that affect productivity and wealth creation, and future prosperity. The widespread adoption of AI has strong parallels with the
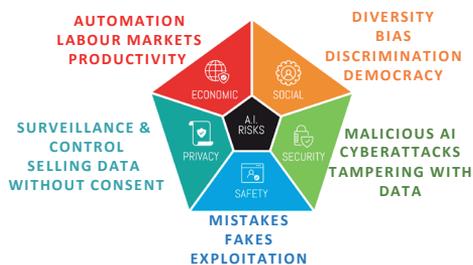
Figure 1: Risk categories associated with AI

British industrial revolution, in which there was an explosion of technology but wages were stagnant for an 80-year period. Other economic risks can arise from the misuse of AI, and poorly designed AI can lead to business failure and major reputational damage.

Privacy Risk: AI companies including Google, Facebook, Twitter and Yahoo! have experienced epic privacy failures revealing billions of consumers' data without consent for profit, by accident and malicious attack.

Authoritarian governments use AI to impose regimes of surveillance and control by collecting and using data for specific purposes without permission. The social credit system implemented in China exploits citizen data to award privileges and impose punishments, enabling and disabling participation in society.

Digital identification systems can lead to rampant exploitation and abuse, to the significant disadvantage and detriment of individual freedoms and rights.

AI companies like Uber use AI to allocate work to humans. AI fuels the power shift to companies away from government oversight, and from consumers' and citizens' control. Many consumers know that AI companies track and analyse their activities and behaviour. However, they do not have meaningful choices, access to information about how

their private data are exploited, or the ability to control access to data that impact them.

Safety Risk occurs when AI systems are poorly designed, not reliable, unpredictable or not robust. Risk can arise from vulnerabilities in AI algorithms and systems. AI is still more of an art than science, and few engineering standards have been developed to ensure safety. Today, AI can process vast amounts of data and outperform human experts in a growing array of tasks. However, it is far from perfect. The dominant AI algorithms today based on Deep Learning are greedy for data requiring huge volumes, sensitive and brittle to changes in parameters and data sources, and are not transparent. Researchers have shown how deep learning algorithms can confuse the image of a dog with a muffin, and how easy it is to fool and hijack them.

The development of AI is challenging as the field lacks robust engineering practices to ensure its safe application. As AI becomes more pervasive in business and society, leaders inside and outside the field have raised concerns, calling for more accountable, transparent, fair and explainable AI.

Security Risk involves the intentional interference by unauthorised parties. It can give rise to bullying, hacking, scams, fraud, loss of identity, mobility, property damage, and in extreme cases, life. AI can be used as an effective tool to perpetrate security breaches and to perform targeted scams using intelligent scareware, adware, spyware, and phishing.

The power and scale of AI are causing security threats to diversify and new types of attacks to emerge. A recent report on the malicious uses of AI identifies three main categories of security risk:

1. *Digital security risks* that arise from an increase in AI-enabled cyberattacks. Some examples include: (i) the use of AI to undertake large scale autonomous attacks that previously required significant human effort, such as spear phishing; (ii) exploitation of human vulnerabilities, such as speech synthesis for impersonation; (iii) exploitation of existing software vulnerabilities through automated hacking; and (iv) exploitation of AI system vulnerabilities using adversarial AI and data poisoning.

2. *Physical security risks* arise from the hacking of AI systems that are used to automate tasks in physical systems, such as nuclear power plants and energy grids. The malfunction of these cyber-physical systems controlled by AI systems poses serious dangers to physical security.

3. *Political security risks* arise from AI-enabled surveillance, persuasive propaganda through targeted misinformation, and deception. For example, "deep fakes," where digital content is manipulated by AI technologies to intentionally deceive, will enhance privacy invasion and social manipulation. AI will continue to improve its ability to manipulate and take advantage of individuals, citizens, groups and organisations.

Social Risk is associated with biased data used in AI algorithm training including lack of diversity and inclusion; laws including discrimination; threats to democracy; the right to freedom of thought, opinion and expression; the freedom of peaceful assembly and association; the right to liberty and social and cultural rights; unequal consumer treatment, financial fraud and identity theft; manipulative marketing and social instability. Applying AI to manipulate human behaviour and proliferate disinformation are

risks that affect human rights, and global peace and security.

Quest for AI Leadership Supremacy

The US and China have identified AI as a critical capability. China has declared that it wants to be the global leader by 2030.

The US government is dramatically increasing its funding and also bringing future funding forward. It upscaled its strategic investments with the release of the National Artificial Intelligence Research and Development Strategic Plan in 2016.

The Big Five US companies (Google, Microsoft, Apple, Amazon and Facebook) make breathtaking undisclosed investments in AI directly and increasingly through acquisitions. According to Pitchbook data the global AI market is expected to expand at a compound annual rate of 36.6% from US$21.5bn to US$191bn between 2018 and 2025. In 2018 there were 146 AI mergers and acquisitions valued at US$213bn. Google made 8 acquisition deals, Apple 7, Intel 6, Microsoft 5, Amazon 4 and Facebook 3.

Many other companies across a wide range of industries such as Ford, Uber, Tesla and FedEx are also investing in AI, IoT, and robotics.

The US and China have emerged as the AI superpowers on almost every metric (Dutton, 2018). For example, according to *CB Insights*, in terms of the quantity of AI startup companies, US has 1394 in 2018: China 283, UK 245, India 84, and Australia less than 30. *CB Insights* also ranks AI startup companies. Australia does not have one in the top 100, the US has 67, China, UK, and Israel 6, Canada, Japan, India, Sweden, and Germany 1.

National governments including Canada, China, France, Japan, South Korea, and Sin-
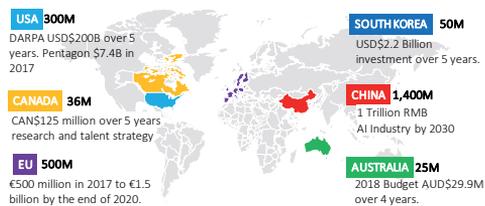
Country	Pop Millions	Source	Amount
USA	327		
		Defence Dept	US$2b in 2019 US$4b in 2020
		NSF, NIH, NIST and Dept Energy	US$850m
China	1420	Government	1 RMB
Canada	37	Government	CAN$125m over 5 years for National Strategy CAN$49M for AI-Health Data Platform
EU	512	EU Commission	€500m in 2017 to €1.5b in 2020
South Korea	51	Government	
Japan	127	Government	¥77.04m
Australia	25	Government	$30 AUD over 4 years

Figure 2: Population versus AI Investment

gapore are prioritizing AI. They view AI as essential to growing their economies in the 21st century.

Canada is a long-time leader in AI research and working with industry including Google and Uber. The Canadian government developed a C$125 million plan to invest in AI research and talent development. The strategy has four goals: (i) increase the number of AI researchers and graduates, (ii) establish three clusters of scientific excellence, (iii) develop thought leadership on the economic, ethical, policy, and legal implications of AI, and (iv) support the national research community on AI.

China has a significant advantage in the areas that tend to determine AI success: people, financial investment, flexible or non-existent regulation, and access to data.

AI in Australia

AI research in Australia, relative to the AI leaders, could only be described as a boutique activity. Not surprisingly, the government has made modest investments in AI research, AI education, AI knowledge transfer and value creation. The Australian Research Council data – Figure 3 – shows major investment in quantum computing but not computer science or AI.

Despite the Australian economy's continuous growth for more than two decades, our innovation performance, innovation-related business collaboration, and industry engagement with universities and research organisations remains steady. Australia is one of the worse performers in the OECD in knowledge transfer. The reality is that Australia is punching well below its weight in areas that determine a nation's future safety, security, productivity and prosperity.

The private sector in Australia focuses on adoption of AI rather than breaking new ground in research, development and innovation with R&D investment dropping dramatically according to ABS data, particularly between 2014-2016, the critical years when AI developed and proliferated rapidly.
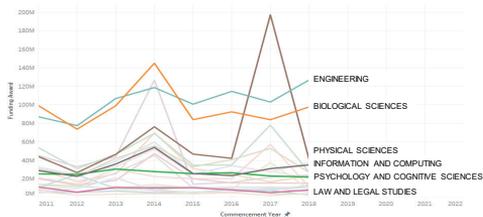
Figure 3: Australian Research Council Funding 2011–2018.

In 2015 Australia spent 0.4% of GDP on research and development, with higher education gaining 35% of the spend. By comparison South Korea spends 1.18%, the US 0.75%, and the UK 0.57%.

However, there are positive indicators that suggest that Australia ranks well on AI preparedness. But readiness for AI is a two-edged sword, as it not only creates opportunity for Australian firms to exploit, but provides more opportunity for firms based in other countries with AI products ready to deploy. Australia has become the playing field for companies in the US, China, and elsewhere that can readily provide high-quality AI software and suitable hardware e.g. phones, robots, drones, and IoT[1].

Australia does not yet have an artificial intelligence strategy or roadmap. However, in the 2018–2019 Australian budget, the government announced a four-year, AU$29.9 million investment to support the development of AI in Australia: the equivalent of *30c per Australian per year to invest in AI*. These funds will be used to create a Technology Roadmap, a Standards Framework, and a national AI Ethics Framework to support the responsible development of AI. The investment will also support Cooperative Research Centre projects, PhD scholarships, and other initiatives to increase the supply of AI talent in Australia.

A Leadership Roadmap for Australia

AI is not just impacting business and society today, it is shaping humanity and the future. Those who can deploy AI have tremendous power and influence. Increasingly, corporations are becoming the regulators, but they are not suited to the task because of their profit motive and conflict of interest e.g. as custodians of the customer data they exploit for economic and market advantage.

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[1] The Internet of Things.

It is critical for Australia to develop a roadmap that ensures it can move into, and sustain, a leadership position as quickly as possible. We urgently need a game plan for a coordinated broad-based strategic response.

Australia is not a leader in AI today, but it is surprisingly well placed to take a leadership position. We have high levels of AI preparedness, a research, innovation and education ecosystem with scope for improvement, underpinned by a robust economic, legal and political framework, and a propensity for technology adoption. By simply reducing the risks associated with AI and addressing the challenges we can compete with larger stronger nations to attain dramatic increases in productivity and fuel future prosperity. We must act to stop foreign interests seizing a dominant position in Australia able to collect and control access to our data, and reap the rewards that AI can generate. The following four strategies that should include new funding and aggressive targets could be used to propel Australia into a leadership position in AI.

Strategy 1: *Develop and enforce effective policy and governance of AI for maximal benefit.* This will entail regulating and setting the objectives for AI. Government, policy makers, and regulators need to play a major role in determining how to incentivise the development of AI that can be trusted.

Strategy 2: *Ensure AI is used to provide equitable access to its benefits and that it is not used to build and abuse power.* AI can help create considerable market power as AI companies have historically been able to dominate markets and establish themselves as pseudo regulators. AI-driven dynamic pricing can be exploited to increase power effect abuse. AI should be beneficial to all: users, customers, citizens, developers and researchers need access to AI. Exclusions need to be removed. Government and business need to remove the significant barriers to entry in AI development, application and usage. Public value and access to AI need protection.

Strategy 3: *Design, develop and deploy responsible AI.* Responsible AI benefits humans. It is transparent, accountable, fair and explainable. Organisations need to set guidelines on AI development and its usage. When AI is solving economic or industry problems or optimising solutions, what are its settings and measures, how is success assessed, what constraints are needed — is it a decision support tool or does it actually make the decision? The foundation of ethics is values; what will the values we use to shape AI in Australia be? If we do not develop AI with the values we want, will we be able to safely import it?

Strategy 4: *Build internationally competitive education and training programs, and national capability and capacity for an AI future.* Lack of capability and capacity is one of the main bottlenecks to AI leadership in Australia. It is critically important to remove obstacles and develop incentives to dramatically increase the number of people taking up training in AI, its applications, its implications for business and society, AI policy, governance, and responsible development.
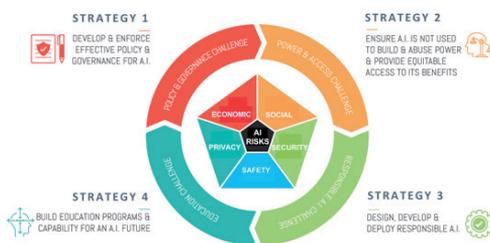
Figure 4: Strategies for Australia to achieve a leadership position in AI and boosting productivity.

Discussion

A critically important realisation is that in order to attain a leadership position in AI all four strategies need to be implemented in a coordinated fashion as they are all closely interrelated and must work together for maximal impact. For example, government needs to set policy and provide resources to ensure Australia produces the optimal quantity and quality of AI experts in engineering and the broader professions to fill the capability and capacity gaps. Responsible AI can and will only be developed in an environment where government has provided effective economic incentives and legal constraints.

There are no silver bullets, but what matters in the AI leadership race is having a clear understanding of where we are currently positioned, why it is critical to win, and how the risks will be mitigated and the challenges addressed to be a genuine AI leader.

The evidence that AI is worth investing in is overwhelming. Since the future of AI is uncertain, the most important strategy in uncertain times is to experiment, act, learn quickly, and reduce the uncertainty. Waiting for more certainty, and not acting with clear intent and relentless vigour, is Australia's highest risk.

Being a leader in an AI world is a challenging complex problem, requiring an integrated innovative solution. The usual methods of slicing and dicing to reduce complexity are probably not effective.

Australian governments, law and order policy makers, and regulators need to work together to help resolve the expected skill bottlenecks and tensions; to boost the adoption of AI technology to make it more human-centric, scalable and productive, using a combination of market and government incentives and constraints. These advances will not happen fast enough organically. They need to be accelerated. Now is the time to be proactive. AI leadership is within our grasp. It must be made a strategic objective and we must use the time available wisely to mitigate the risks and address the challenges to make Australia's leadership in AI a reality. The key is shared ambition to lead fuelled by need and coupled with strategic collaboration, cooperation and coordination across government and industry.

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