

Research Bulletin 23/4 | AI Advancements Explained, and the Perspectives of Industry and Government

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Summary

This article explains and considers recent advancements in Artificial Intelligence (AI) and what these may mean for future economies and societies. It considers the opportunities, benefits, risks, and challenges of AI and how governments have responded to these so far. This article also considers the recommendations experts in the field of AI have made to minimise AI risk. It finds that there is broad consensus between AI experts and governments to work together to find adequate safeguards for AI.

Introduction

This Research Bulletin explains what Artificial Intelligence (AI) is and discusses recent developments in the field. It looks at how AI may affect labour markets and discusses different views on what the opportunities and risks with AI are. It also looks at what experts in the field say about AI and discusses what the current approach of governments has been in relation to AI regulation.

Artificial Intelligence Explained

What is AI?

Artificial Intelligence (AI) refers to the development of computer systems that can perform tasks which would typically require human intelligence, such as visual perception, speech recognition, decision-making and language translation. AI technology has the potential to revolutionize the way we live and work, and is being used in a growing number of fields, including healthcare, transportation, finance, and manufacturing.

AI is already used in many ways across many different business sectors. These include self-driving tractors; online advertisements; video advertisements; managing supply chains; sifting job applications; and curating social media feedsⁱ.

Recent attention around AI has focused on chat bots, which have been released to the public and have (with varying degrees of success) been able to produce written material on a range of topics and in a variety of styles. This paper will focus on the most recent breakthroughs in AI, the future of these breakthroughs and what they could mean for economies and societies more broadly.

Four Main Types of AIⁱⁱ

1.

Reactive machines:
relatively simple and
follow strict rules



Reactive machines are designed to perform a specific task based on a given set of rules without any ability to form memories or use past experiences to inform future decisions. Examples include Deep Blue (a chess-playing computer) and AlphaGo (a computer program designed to play the board game Go).

2.

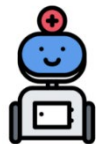
Limited Memory AI: can
use past experiences to
inform future decisions



Limited Memory can store data for a short period of time. These AI systems use past experiences to inform future decisions. Self-driving cars are an example of limited memory AI systems.

3.

Theory of Mind AI:
understands human
behaviour and thought
allowing more natural
interactions with humans



Theory of Mind is designed to understand human emotions, beliefs, and thought processes, and to use that understanding to interact with humans more naturally. This type of AI is still largely in the experimental phase, but it has potential applications in fields such as mental health care and education.

4.

Self-aware AI: conscious
and able to understand
its existence
(unknown if achievable)



Self-Aware AI have consciousness and the ability to understand their own existence. This type of AI is still largely hypothetical, and there is much debate within the scientific community about whether it is even possible to create such an AI.

Source: Forbes - 7 Types of Artificial Intelligence

Broadly, AI can be divided into two categories: narrow and generalⁱⁱⁱ. Narrow AI is created to solve a delineated set of problems e.g., a chatbot like Chat GPT. General AI (or Artificial General Intelligence – AGI) is where AI can be applied in any domain, solving any problem that requires intelligence.

An extension of AGI is Artificial Super Intelligence (ASI) – this is where AI can solve any problem at a capability that far surpasses human capabilities. Due to the nature of computer processing, it is likely that if AGI is achieved then this will quickly entail the creation of ASI.

Large Language Models

Large Language Models (LLMs) are the systems used to power AI chatbots such as those released by Microsoft, Alphabet and others in recent months. They use machine learning techniques to analyse vast amounts of text data and then learn to predict the likelihood of words and phrases that come next based on what they have seen before. This enables the models to generate largely coherent and contextually appropriate responses to text-based queries, making them useful for a wide range of applications such as language translation, chatbots, and content creation.

They are trained on vast amounts of data and this process is very resource intensive. It is for this reason that large technology firms are currently leading the field because they have access to vast amounts of data and billions of dollars to spend on research^{iv}.

Potential downsides and risks with Large Language Models and, more broadly, machine learning approaches are:

- **Text can be generated which appears credible but which has in fact been misconstrued or has no factual basis.** For example, LLMs have been known to cite journal articles that don't exist. According to work by Nina Schick, this poses the potential for vast amounts of disinformation to be generated in extremely brief periods of time^v.
- **Societal biases can be perpetuated and amplified if they exist in the data the models are trained on.** For example, a large online retailer had to stop using a recruiting tool when it was discovered that it favoured men over women for technical jobs^{vi}.
- **LLMs tend to require a lot of energy to be trained and to operate.** This poses problems for climate change and means market power is likely to be concentrated in the firms who can afford to expend the amounts of resources required to develop these models. That being said, a recent article in *The Economist* quoted a tech industry source as saying: "The barrier to entry for training and experimentation has dropped from the total output of a major research organisation to one person, an evening, and a beefy laptop."^{vii}
- **Human skills like critical thinking and creativity could deteriorate** if there is a large shift toward or overreliance on these forms of AI for tasks like writing, research, or decision making. This could lead to a dependence on them and ultimately negatively impact people's ability to be creative and think critically^{viii}.

Recent Developments in AI

AI launches and advancements have become very prominent in the public eye and discourse of late. It has been reported that this "frenzy" has caused some large tech companies to shift their entire corporate strategies in order to seize control of what they believe will become a new infrastructure layer of the economy^{ix}.

Table 1 shows how rapidly AI advancements have happened. This comes as the resources and data being put into AI have grown exponentially.

Table 1: The Growth of AI Capabilities in the Past Decade^x

	2012	2022
Compute used to train largest AI model	1e+16 FLOPS (10,000,000,000,000,000)	1e+24 FLOPS (10,000,000,000,000,000,000,000,000)
Data consumed by largest AI model	Imagenet: a dataset of 15mn labelled images (150FB)	Datasets of more than 2bn images or much of the text on the internet (estimated at 10,000GB)
Capabilities of largest AI model	Can recognize images at 'beginner human' level Superhuman at chess	Superhuman or high-human at a wide variety of games (Go, Diplomacy, Starcraft II, Poker, etc.) Human-level at 150 reasoning & knowledge tasks Passes US Medical Licensing Exam, passes the Bar Exam Displays complex capabilities like power-seeking, deceiving humans Can self-improve by "reasoning" out loud Can write 40 percent of the code for a software engineer

Source: Hogarth, I.: FT Weekend Magazine April 15/16, 2023, p. 23

Artificial Intelligence and the Economy

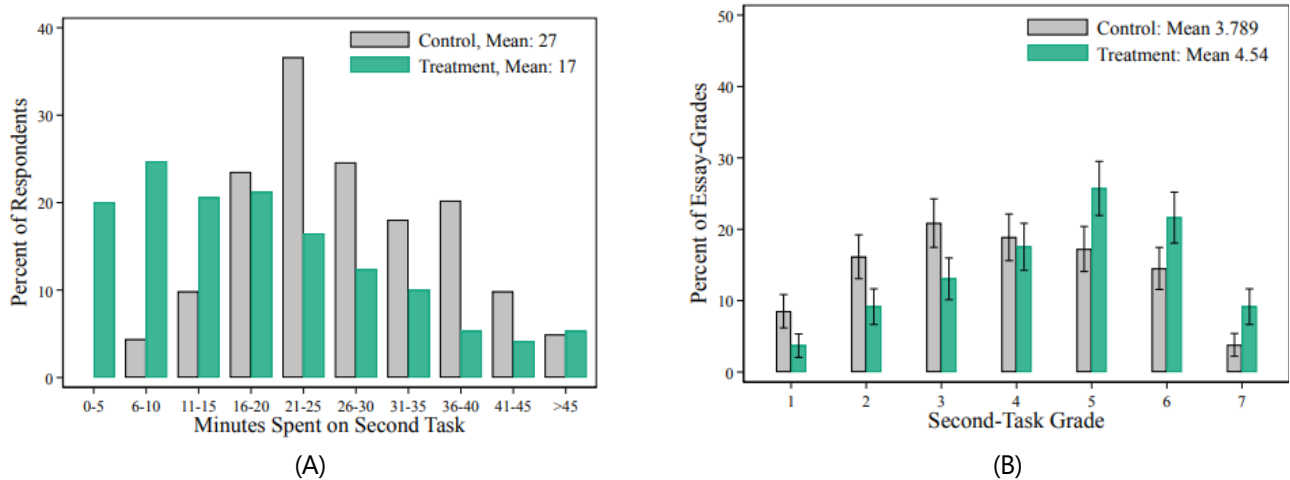
How AI could affect labour markets

AI has the potential to cause significant changes to peoples' lives in multiple ways, with one of the main ways being transformative change in the job market. In the same way that for hundreds of years automation has replaced or augmented physical labour jobs, AI now has the potential to do the same thing with more cognitive-based jobs. A major reason AI has garnered a lot of attention recently is because of the potential it has to disrupt large proportions of the labour market in a very short time scale. As AI systems become more sophisticated, they are likely to replace more tasks currently performed by humans and by extension replace some or many jobs that humans currently have.

It is likely that most jobs will incorporate some level of AI into their tasks, rather than the technology entirely replacing human workers. This means that workers will potentially be more productive and that relatively less labour will be required for the same task. This is typical of labour-saving technologies that generate productivity gains. For instance, a recent paper (not yet peer reviewed) from MIT researchers randomly assigned ChatGPT to half of the participants in occupation specific, incentivised writing tasks. Their results found that use of this AI software significantly increased

productivity, increased test scores and benefited low-ability workers more – reducing inequality across workers (see Figure 1 (A) and (B) below) ^{xi}.

Figure 1 (A) and (B): ChatGPT Reduces Average Time Spent on Tasks; ChatGPT Improves Average Grades of Workers



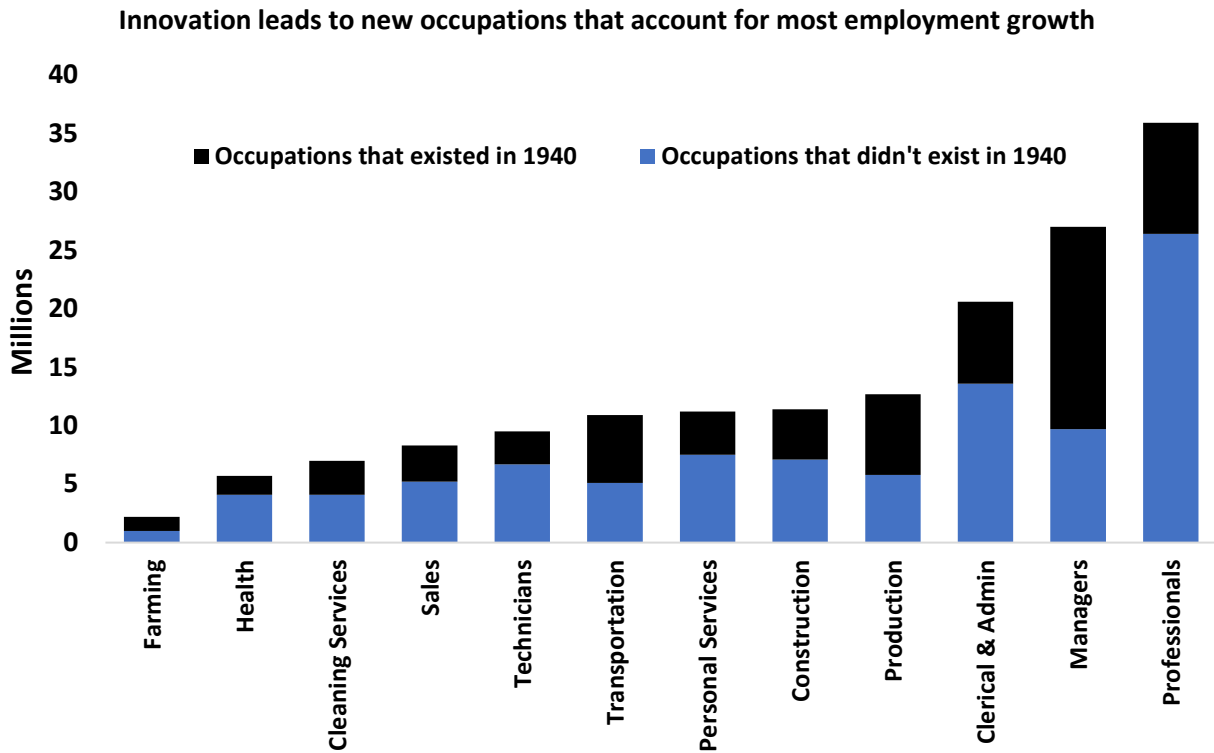
Source: Noy, S., and Zhang, W., (2023)

Research conducted by PwC for the Department for Business, Energy and Industrial Strategy found a positive correlation between employment effects of AI and education levels^{xii}, meaning that AI was found to have a more positive effect on employment for more educated people and a less positive effect on employment for less educated people. It should be noted that this research was published in August 2021, more than a year before the first generative AI models such as ChatGPT were released to the public. OpenAI, the company that released ChatGPT, has found in its own research that occupational exposure to AI (i.e., how exposed workers are to being replaced by AI) increases with more credentialed workers^{xiii}. The conflicting nature of these findings highlights the degree of uncertainty there is about the impact AI will have on workers.

Concerns have been expressed that AI could lead to significant economic disruption through adverse labour market impacts^{xiv}. However, AI could also create new job opportunities and it is worth remembering that traditionally, technologies that have replaced workers have not led to higher unemployment in the long run for societies. Rather, they have contributed to sustained improvements in living standards for humans.

Additionally, recent research has found that 60% of today's workers in the US are employed in occupations that didn't exist in 1940. It is implied from this that over the last 80 years 85% of employment growth in the US has been explained by the technology-driven creation of new positions. ^{xv}

Figure 2: Employment Growth in US by Occupations Created Pre and Post 1940



Source: Autor, D., Chin, C., Salomons, A.M., and Seegmiller, B., (2022)

A recent study by Goldman Sachs has found that 300 million full time jobs globally could be affected by AI over a 10-year period^{xvi}. This research states that roughly two-thirds of current jobs are exposed to some degree of AI automation while generative AI (AI that can generate text, images or other media in response to prompts) could substitute up to a quarter of current work. However, it should also be noted that predictions about the impact and timescale of AI have been wrong in the past^{xvii}, such as a 2013 University of Oxford study which stated that 47% of US jobs could be eliminated by computerisation (including machine learning and AI) over the next 10 - 20 years^{xviii}.

Additionally, America’s Bureau of Labour Statistics has found that jobs which are classified as being more vulnerable to new technologies, “did not exhibit any general tendency toward notably rapid job loss”^{xix}.

That being said, recent developments have shown that the latest iteration of AI chatbots are already having an impact on the economy. For example, in May 2023 BT announced that it plans to cut up to 42% of its workforce (55,000 roles including third-party contactors) through digitisation and automation. BT’s chief executive stated, “for a company like BT there is a huge opportunity to use AI to be more efficient,” and stated that generative AI would bring huge advances^{xx}.

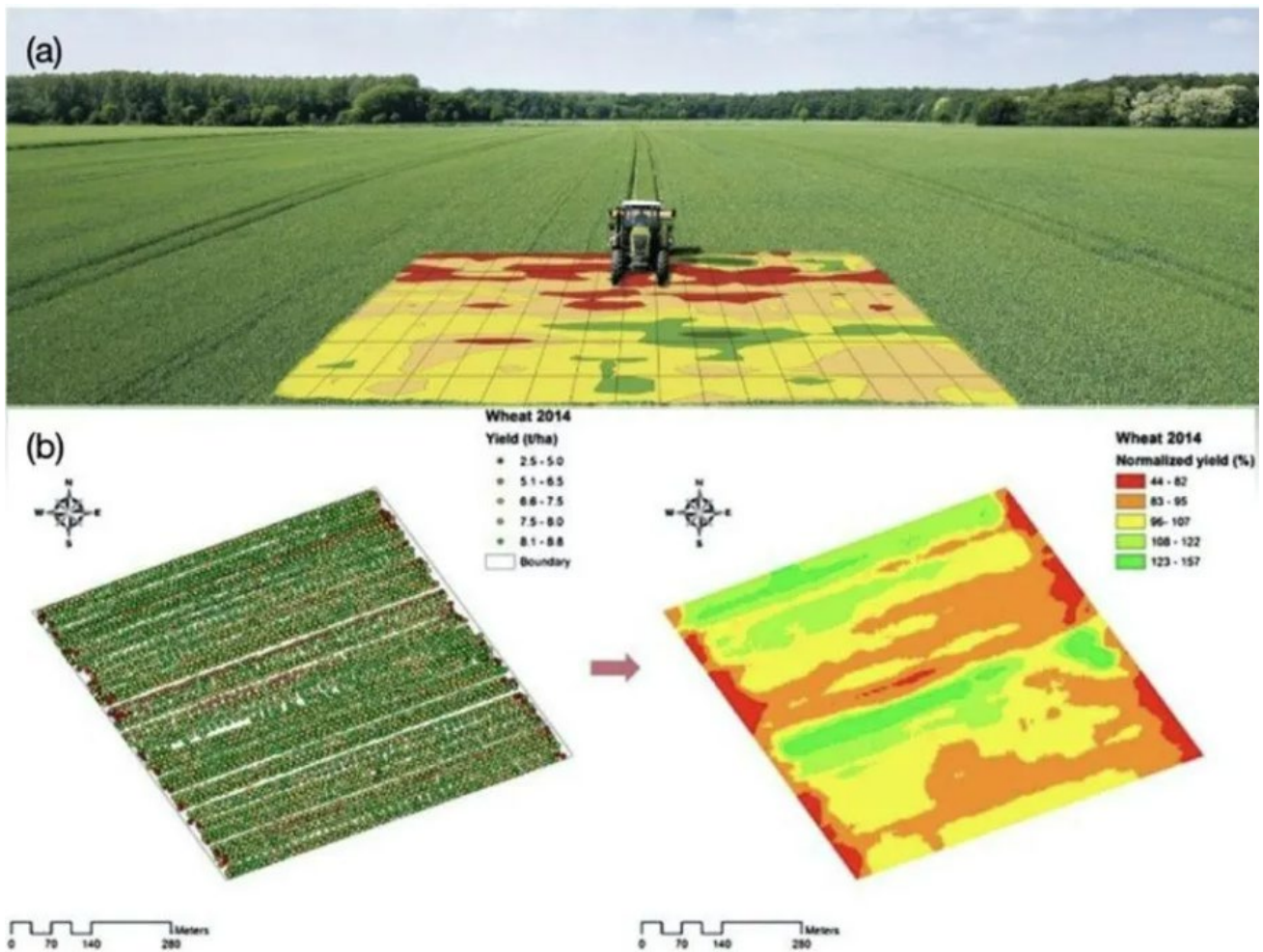
The impacts of AI on business were also demonstrated recently when share values in the education sector were negatively impacted by investors pricing in AI’s potential to disrupt business models focused on the provision of study guides and other support materials to students^{xxi}.

Examples of how AI is already being applied to specific sectors of the economy

Agri-food

AI is currently being used in the Agri-food sector to improve the efficiency of production, improving crop yields, and reducing food production costs^{xxii}. This includes the use of autonomous robots and tractors which map and prepare fields; using drones combined with in-ground sensors to improve pest management; monitoring the health of livestock; and using self-propelled robotics machinery to distribute fertilizer on rows of crops^{xxiii}.

Figure 3: Example of AI display which is used to improve farming techniques^{xxiv}



Source: Talaviya, T., et al., (2020)

Bioscience

Recently, a UK-based AI company solved "one of biology's grand challenges": predicting how proteins fold from a chain of amino acids into 3D shapes that carry out life's tasks^{xxv}. Before DeepMind deployed their AI technology, AlphaFold, to solve the problem only about 170,000 protein structures had been solved out of the more than 200 million proteins discovered across life forms. This AI technology has reduced the time it takes to solve a protein's structure from years or even decades of laborious experimentation to only a few hours^{xxvi}.

The knowledge of a protein's structure has numerous applications. This includes: drug design; disease understanding; evolutionary insights; protein engineering; vaccine development; material science; and diagnostics^{xxvii}.

Creative Industries

AI has the potential to be a significantly disruptive factor in creative industries such as film, television, and music. In film and television, studios have proposed paying actors for one day of work so that their likeness and image can be scanned, which the studios could then use in perpetuity^{xxviii}. There is currently a Screen Actors Guild and the American Federation of Television and Radio Artists strike in place over fears for how this will affect people's livelihoods and the negative impact this may have on the talent pool of Hollywood^{xxix}. The implementation of AI may also have implications for voice dubbing used in movies and television. This is because it is now possible to replicate a person's voice and tone using AI. So rather than using a voice actor to repeat a person's lines in a different language, the AI will be able to generate the original speaker's voice.

In the music industry, songs have emerged that use the likeness of singers' voices, but which have in fact been generated by AI^{xxx}. Most of these songs have been removed from streaming platforms due to the threat of legal action by the publishers of these music artists. However, whether copyright law applies to these AI generated songs is a complex issue which is debated amongst legal professionals^{xxxi}.

Education

AI is being applied to the education sector to improve the delivery of teaching methods to students. AI is currently being used to automate many time-consuming administrative tasks in teaching such as grading assignments and detecting plagiarism^{xxxii}.

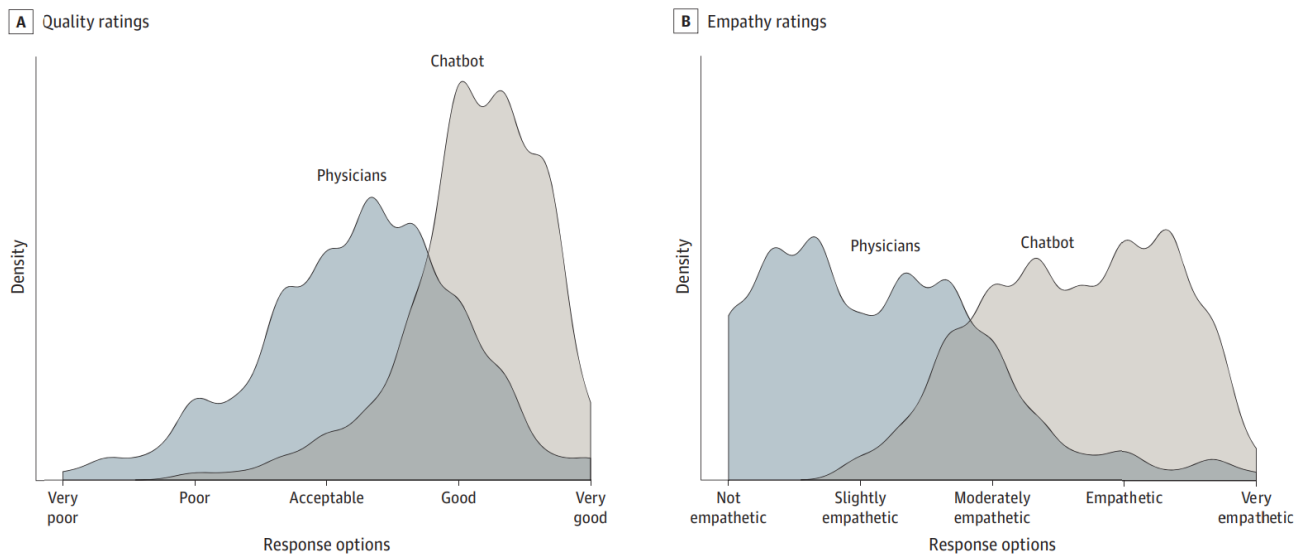
Some language teaching apps already use AI to create personalised educational experiences and to understand how they can make their lessons more effective^{xxxiii}. A result of this is that studies have found that completing a course on a specific language teaching app that employs AI (Duolingo) has the same level of effectiveness as completing five semesters of university language instruction^{xxxiv}.

Healthcare

AI is being deployed in numerous ways to improve the healthcare of patients^{xxxv}. Broadly, this includes improving: diagnostics; decision making; treatment; and end of life care. AI is also used in technology applications and apps to encourage healthier behaviour in individuals. Additionally, this AI technology allows medical professionals to better understand the lifestyles of their patients which improves the understanding of their patients' needs. AI is also already being used to detect diseases, such as cancer, more effectively and earlier than humans by themselves are able to. For instance, the use of AI is enabling mammograms to be reviewed and translated 30 times faster with 99% accuracy, helping to reduce the need for unnecessary biopsies.^{xxxvi}

There is also scope for AI to further improve patient waiting times and the overall efficiency of health care systems. A recent study found that an AI chatbot’s responses were preferred over a physician’s responses to patient questions posted to a public social media forum. The AI’s responses were rated significantly higher in terms of quality and empathy when judged by a team of physicians who did not know which responses came from the human physician and which came from the chatbot^{xxxvii}.

Figure 4 (A) and (B): Quality and Empathy Ratings for Physician and Chatbot Responses to Patient Questions



Source: Ayers, J.W., Poliak, A., Dredze, M., and Leas, E.C., (2023)

Artificial Intelligence and Northern Ireland

Northern Ireland’s Research Institutions

Northern Ireland’s research institutions have a track record and strength in AI, with the 2019 Turing Report^{xxxviii} highlighting the quality and range of AI research being undertaken at both Ulster University and Queen’s University Belfast. The report recommended the establishment of an AI Centre of Excellence with strong academic, industry and government collaboration at its core^{xxxix}. Subsequently, proposals to establish an AI Collaboration Centre (AICC) have been developed, aimed at supporting the development of the region’s AI sector.

City Deal Investments in AI

In Northern Ireland, government-supported investments are showing strong alignment with the AI Roadmap - an independent report carried out by the AI Council which provided recommendations to help the UK government’s strategic direction on AI^{xl}. This is because NI has seen significant funding directed towards ICT and innovation through City and Growth Deals for the Belfast and Derry & Strabane regions^{xi}. The Belfast City Deal, which has secured nearly £1bn in funds, sees joint contributions from the UK government, the NI Executive, and various City and Growth Deal

partners, including the private sector and academic institutions. The Derry & Strabane deal will benefit from a £50m UK government fund, boosted by another £55m for the Inclusive Future Fund. Both deals have strong AI-focused projects, including Belfast's Global Innovation Institute, and Advanced Manufacturing Innovation Centre. The Derry & Strabane deal is anchored in projects like the Cognitive Analytics Research Laboratory and the Centre for Industrial Digitalisation. Furthermore, a pioneering Digital Twin centre, steered by Artemis Technologies with a £50M investment, will emerge in Northern Ireland, focusing on digitalisation in design and manufacturing. This initiative, paired with two impending critical projects, presents a unique opportunity for Northern Ireland to harness both private and governmental investments, aiming for advancements in net zero, national security, and skill-driven technological development.

Sector Opportunities for AI in Northern Ireland

Matrix has conducted research^{xlii} to inform the sectoral focus of the AICC. Five sectors in NI were highlighted for their relative attractiveness regarding the implementation of AI: Advanced manufacturing, materials and engineering (AMME), biomedical R&D and pharmaceutical manufacturing, cryptocurrency and cyber security, finance including FinTech, and human health and social work. These are summarised below:

- **AMME:** Significant potential with AI in robotics and 3D printing, supported by initiatives like the Belfast Region and Derry & Strabane City Deals. To leverage its transformative potential, it will be key for sector leaders to embrace AI solutions and to focus on the sub-sectors where NI's expertise is highly specialised and exportable, such as in machinery and transport equipment.
- **Biomedical R&D and pharmaceutical manufacturing:** Shows promise with AI in life sciences though challenges exist due to a crowded marketplace.
- **Cryptocurrency and cyber security:** NI has an established cyber security cluster though challenges around current scale and the availability of investment capital may affect ability to compete nationally and regionally.
- **Finance, including FinTech:** Demonstrates high AI maturity with potential for impact, supported by the cyber cluster. To build on its opportunity for distinct impact, it will be crucial that NI leverages the sector's largest players and start-ups and builds on its expertise in building software.
- **Human health and social work:** Presents numerous AI opportunities - it is one of the largest sectors of NI's economy, with many cross-cutting initiatives and companies active in the field. But it faces challenges in industry readiness in healthcare settings.

There is strong alignment between the sectors highlighted by Matrix and the priority clusters outlined in the Department for the Economy's 10X economic vision and it is hoped that the AICC will contribute positively to achieving the Department's 10X objectives, exploiting the windows of opportunity available from integrating AI into these sectors; preparing a future generation of workers who can drive economic growth; and diffusing innovation from this centre into the wider economy.

Challenges and Risks with Artificial Intelligence

Regulatory Challenges

There is an emerging consensus that AI presents many opportunities such as improving the efficiency of workers and growing global GDP as previously discussed in this paper. But there is also a collective acknowledgement that AI presents a unique set of risks and challenges such as those captured in the 2023 edition of the UK Government's National Risk Register^{xlii} and recently expressed by the US Secretary of State and the US Secretary of Commerce who acknowledged AI risks such as generating false information, reinforcing bias and discrimination, being misused for repressive or destabilising purposes or proliferating knowledge that could threaten national security.^{xliii}

The scope and scale of AI and its rapidly improving capabilities has the potential to pose significant challenges in terms of developing a tailored and responsive regulatory framework. In March of 2023 a number of prominent figures within the AI community signed an open letter calling on AI labs to immediately pause the training of AI systems more powerful than GPT-4 for at least six months due to the destabilizing effects they may have on societies and the small potential for spillover into Artificial General Intelligence (AGI: self-aware AI)^{xliv}. Concerns listed include the proliferation of false information and harmful media, automation of too many jobs, and the development of "minds" that are highly intelligent and which could pose unprecedented challenges. The open letter calls for the development of robust AI governance systems and has over 27,000 signatures including from significant figures such as Stewart Russell (an internationally acclaimed AI scientist), Steve Wozniak (co-founder of Apple) and Valerie Pisano (CEO of the Quebec AI Institute).

Governments have signalled that they are aware of the concerns that industry leaders in AI have voiced and are considering how to craft regulations to mitigate the risks while allowing the opportunities AI presents to be maximised. The Prime Minister of the UK recently stated that "guardrails" should be put in place to monitor the progress of AI^{xlv}, while Italy recently ordered Chat-GPT to temporarily stop processing Italian users' personal data amid concerns over compliance with laws such as GDPR^{xlvi}. Concurrently, major legal questions exist over who has ownership and the rights to AI outputs^{xlvii}.

The EU is currently working on the world's first legislation on AI, though consumer advocacy groups are concerned that it could take years before the AI Act takes effect, leaving a regulatory vacuum around a technology that is potentially harmful.^{xlviii}

The exponential nature of AI advancement means that how the technology is regulated could have material impacts on the scope and scale of an economy's future AI aspirations and the extent and nature of its use. This has led to a wide range of views from governments, regulators, and proponents as to what the correct balance looks like^{xlix}.

Another View on AI Risk

The Economist recently presented an alternative view to the concerns of AI researchers around the level of threat AI may poseⁱ, citing a study that shows that experts and workers in particular fields tend to overestimate the importance of their work. The study was a response to a survey carried out in 2022 which asked AI researchers what they thought the likely outcome of AI advances would be: 48% of respondents gave at least a 10% chance of an outcome which is “extremely bad” (i.e. the realisation of an existential threat); the median researcher placed a 5% (or one in twenty) probability on an extremely bad outcome such as the realisation of an existential threat; while 25% of researchers put the probability of an extremely bad outcome at 0%ⁱⁱ. The same study found that almost seven out of ten respondents believe society should prioritize AI safety research “more” or “much more” than it is currently prioritized.

This comes as the chief executive of Open AI, Sam Altman, has called on US lawmakers to regulate fast-advancing artificial intelligence technology, stating: “I think if this technology goes wrong, it can go quite wrong. And we want to be vocal about that. We want to work with the government to prevent that from happening.”ⁱⁱⁱ

Proposed Solutions to AI Risk

Although there are risks with the AI capabilities that have already been realised, experts’ thinking in the medium to long term tends to focus on the risks with Artificial General Intelligence or AGIⁱⁱⁱⁱ.

They argue that this would pose a significant set of challenges for humanity because for the first time ever there would be an entity of unequalled capability and intelligence. Therefore, if the ASI’s objectives were not perfectly aligned with our own then this could be dangerous^{iv}.

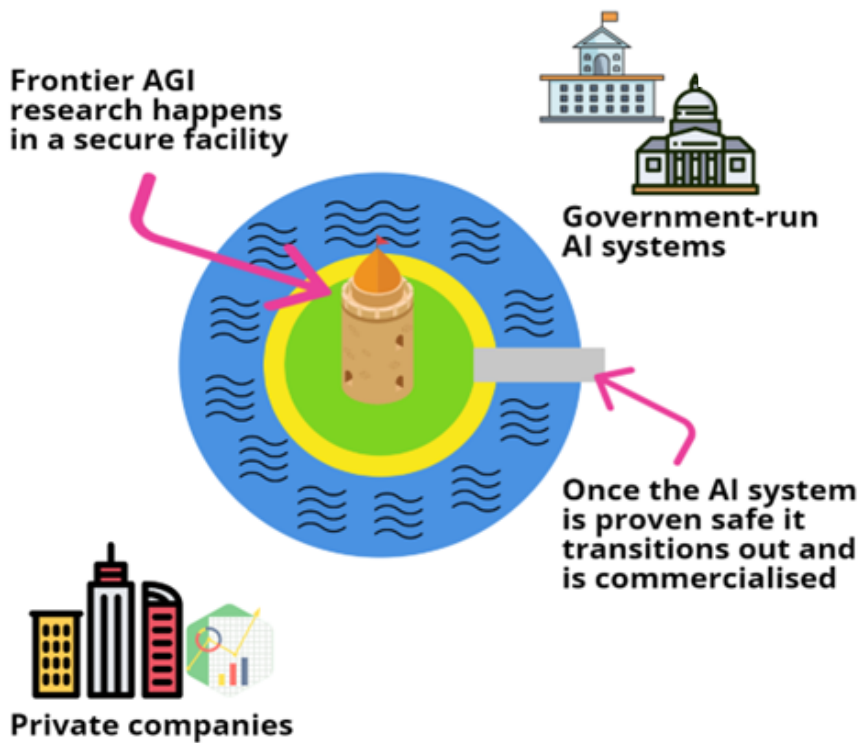
Several individuals in the field of AI have proposed solutions to manage such risks, two of which are considered below:

‘The Island’ Solution to AI Risk

Ian Hogarth, a technology entrepreneur, who was recently appointed as Chair of the UK Government’s Foundation Model Taskforce (which is considering the risks associated with AI and directly reports to the Prime Minister and Technology Minister), has advocated for very strict regulations around AGI systems and their development and less strict regulations for narrow AI which, in his opinion, pose less of an existential risk to humanity^{iv}.

Hogarth calls this approach to AGI ‘The Island’ approach: where experts working on highly capable AGI do so in an extremely secure facility i.e. an air-gapped enclosure with the best security humans can build. All other attempts to build AGI are made illegal and the AGI can only be commercialised “off-island” when it is provably safe. He cites the CERN laboratory as the blueprint for how this could operate.

Diagram 1: "The Island" Approach to AGI Research



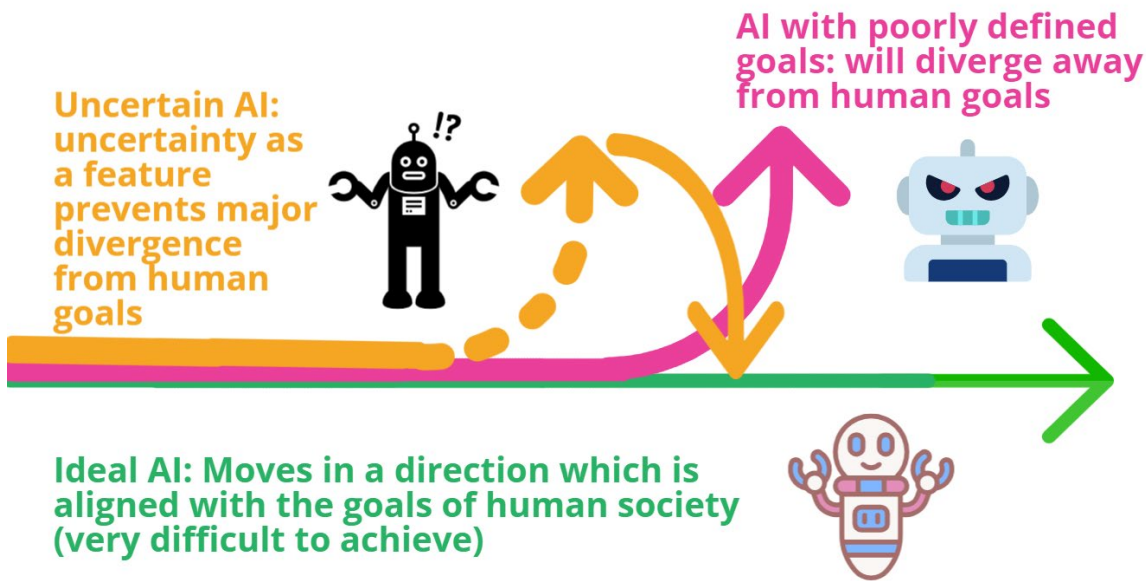
Source: Graphic above designed by V Marangudakis for this Research Bulletin. Hogarth, I. via FT Weekend Magazine April 15/16, 2023, p. 23

Hogarth acknowledges that the solutions he proposes will require an extraordinary amount of coordination between labs and nations and that the political will to implement them needs to start being built now. He also points out that many AI labs are waiting on deliveries of more advanced hardware and that consequently there is a window through 2023 for governments to take control.

Building Uncertainty into AI Models

The renowned computer scientist Stuart Russell has outlined a different approach to tackling AI risk. He would like to see AI systems developed that are "doubtful" about their tasks and that can learn about what humans may want or intend by studying them^{vi}. That way the more they stray from what they think the intended goal is or the farther they move towards what they think their goal is, the less they are likely to do, and ergo the less harm they would be able to do. This would allow for humans to guide them towards more beneficial outcomes.

Diagram 2: Building Uncertainty into AI Models



Source: Russell, S.J. (2020); designed by V. Marangudakis for this Research Bulletin

Russell has joked that an example of the type of result that could be possible if computer science incorporated his recommendations for AI would be: “We do AGI right and the AGI figures out that actually AGI is a really bad idea for the human race and extinguishes itself. If that happens, I would say, okay, we got it right.”^{lvii}

The UK Government and NI Strategies on AI

The UK Government published a 10-year strategy on AI in September 2021 with the intention of making the UK ‘a global AI superpower’^{lviii}. Actions outlined in this strategy come under three broad headings: supporting the AI ecosystem; ensuring AI benefits all sectors and regions; and AI governance/regulation. The UK Science and Technology Framework sets out UK government’s strategic vision and identifies AI as one of five critical technologies^{lix}.

The UK Government has opted for a “pro-innovation” approach to regulating AI as detailed in its White Paper published in March 2023^{lx}. This means the government has opted for a relatively liberal approach to regulating AI. While this could be positive for the pace of AI development, it may also face criticism that it allows for less mitigation of the risks associated with AI.

The 2021 Leading Innovation report found that Northern Ireland lags the UK average in terms of the attainable economic impact of AI and that Northern Ireland has a high and increasing proportion of tech vacancies in comparison to other regions in the UK. AI research in Northern Ireland is present but is less tightly focused or

differentiated than in some other UK clusters. Current venture capital investment in Northern Ireland in emerging tech and AI specifically is also lower than in other regions.

At the same time, the Department for the Economy's 10X Vision outlines "Software engineering and AI" as one of eight enabling technologies that are the foundation of our future growth in Northern Ireland^{lxii} and the Department outlined £2m of additional funding in its Economic Recovery Action Plan to develop proposals to implement an AI centre of excellence.

Conclusion

AI is already transforming our lives in many ways and is likely to continue doing so over the next few decades. It is likely to improve global productivity and output and thus will improve global living standards. At the same time, the power and exponential growth of this technology has the potential to cause significant disruption in a short space of time. It is for that reason that leaders within the AI industry have called on governments to work with them to develop adequate regulations to minimise AI risk without detracting from the benefits AI has to offer^{lxii lxiii}.

Governments appear to share the views of AI industry leaders, with world leaders at the recent G7 summit in Hiroshima, including the Prime Minister of the UK, calling for "guardrails" to monitor the technology and to allow AI to be "safely and securely" introduced into societies^{lxiv}.

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- ⁱ [The Economist: Artificial intelligence is permeating business at last, 06/12/23](#)
- ⁱⁱ [Forbes: 7 Types of Artificial Intelligence, 19/06/23](#)
- ⁱⁱⁱ [Harris, S. \(2023\) *Making Sense of Artificial Intelligence*. 22/11/23](#)
- ^{iv} [The Economist: Big tech and the pursuit of AI dominance, 26/03/23](#)
- ^v SCHICK, N. (2021) *Deepfakes: The coming infocalypse*. S.I.: GRAND CENTRAL PUB.
- ^{vi} [The Guardian: Amazon ditched AI recruiting tool that favored men for technical jobs, 11/10/18](#)
- ^{vii} [The Economist: Your job is \(probably\) safe from artificial intelligence, 07/05/23](#)
- ^{viii} Porsdam Mann, S., Earp, B.D., Nyholm, S. et al. Generative AI entails a credit-blame asymmetry. *Nat Mach Intell* 5, 472–475 (2023). <https://doi.org/10.1038/s42256-023-00653-1>
- ^{ix} [TIME: The AI Arms Race Is Changing Everything, 17/02/23](#)
- ^x FT Weekend Magazine April 15/16, 2023, p. 23
- ^{xi} [Experimental Evidence on the Productivity Effects of Generative Artificial Intelligence \(Noy and Zhang\) - 2023](#)
- ^{xii} [PWC report for BEIS: The Potential Impact of Artificial Intelligence on UK Employment and the Demand for Skills](#)
- ^{xiii} [Eloundou, T., Manning, S., Mishkin, P., and Rock, D., \(2023\), GPTs are GPTs: An Early Look at the Labor Market Impact Potential of Large Language Models](#)
- ^{xiv} [UK Parliament, House of Commons, Vol. 731: Artificial Intelligence and the Labour Market](#)
- ^{xv} [Autor, Chin, Salomons and Seegmiller \(2022\)](#)
- ^{xvi} [Generative AI could raise global GDP by 7% \(Goldman Sachs\)](#)
- ^{xvii} [Oops: The Predicted 47 Percent of Job Loss From AI Didn't Happen \(Information Technology and Innovation Foundation\)](#)
- ^{xviii} [The future of employment: How susceptible are jobs to computerisation? \(Frey and Osborne\) - 2013](#)
- ^{xix} [US Bureau of Labor Statistics; Monthly Labor Review, July 2022](#)
- ^{xx} [Financial Times: BT hails AI opportunity as it unveils plan to cut up to 42% of workforce, 18/05/23](#)
- ^{xxi} [Financial Times: Education companies' shares fall sharply after warning over ChatGPT, 02/05/23](#)
- ^{xxii} [De Baerdemaeker, J. \(2023\) *Artificial Intelligence in the Agri -Food Sector - European Parliament*](#)
- ^{xxiii} [Columbus, L. \(2022\) *10 ways AI has the potential to improve agriculture in 2021, Forbes*](#)
- ^{xxiv} Talaviya, T., et al., Implementation of artificial intelligence in agriculture for optimisation of irrigation and application of pesticides and herbicides, *artificial intelligence in agriculture*, volume 4, 2020, pages 58-73, issn 2589-7217.
- ^{xxv} [Service, R., F. \(2020\) 'The game has changed.' *AI triumphs at protein folding, Science*](#)
- ^{xxvi} [Metz, C. \(2020\) *London A.I. Lab claims breakthrough that could accelerate drug discovery, The New York Times*](#)
- ^{xxvii} [Corvalan, C. \(2020\) *Why Does Predicting a Protein's 3D Structure Matter? The Biological Impact of AI System AlphaFold*](#)
- ^{xxviii} [An all-out strike brings Hollywood to a halt \(2023\) *The Economist*](#)
- ^{xxix} [Espada, M. \(2023\) *How the SAG-AFTRA strike affects TV and movies, Time*](#)
- ^{xxx} [BBC: Deezer: Streaming service to detect and delete 'deepfake' AI songs](#)
- ^{xxxi} [BBC: Drake and The Weekend AI song pulled from Spotify and Apple \(2023\)](#)
- ^{xxxii} [Mahendra, M. 2023. *How is AI Being Used in Education, Artificial Intelligence +*](#)
- ^{xxxiii} [Wodzak, S. *3 ways Duolingo improves education using AI*](#)
- ^{xxxiv} Jiang, X. et al. (2021) 'Finishing half of B1 on Duolingo comparable to five university semesters in reading and listening', *Duolingo Research Report DRR-21-03* [Preprint].
- ^{xxxv} [PricewaterhouseCoopers. *No longer science fiction, AI and Robotics Are Transforming Healthcare, PwC*](#)
- ^{xxxvi} [Griffiths, S. \(2016\) *This AI software can tell if you're at risk from cancer before symptoms appear, WIRED UK*](#)
- ^{xxxvii} [Ayers, J.W., Poliak, A., Dredze, M., Leas, E.C., 'Comparing Physician and Artificial Intelligence Chatbot Responses to Patient Questions Posted to a Public Social Media Forum', *JAMA Internal Medicine, 2023*](#)
- ^{xxxviii} [Matrix.: artificial intelligence research in Northern Ireland, 2019 report](#)
- ^{xxxix} [The Northern Ireland Innovation Stakeholder Group: Northern Ireland response to the AI Council AI Roadmap](#)
- ^{xl} [Gov.uk: AI Roadmap Independent Report](#)
- ^{xli} [Matrix: Evaluation of sector opportunities for Artificial Intelligence in Northern Ireland](#)

-
- xiii [UK Government: National Risk Register 2023](#)
- xliii [FT: Antony Blinken & Gina Raimondo: To shape the future of AI, we must act quickly, 24/07/23](#)
- xliv [Pause Giant AI Experiments: An Open Letter \(Future of Life Institute\); National AI Strategy \(UK Government\)](#)
- xlv [Gizmodo: G7 Summit Leaders Call for Stricter AI 'Guardrails', 20/05/23](#)
- xlvi [Reuters: Italy curbs ChatGPT, starts probe over privacy concerns, 31/03/23](#)
- xlvii [BBC: UK rules out new AI regulator, 29/03/23](#)
- xlviii [Bisoyi, A., Ownership, liability, patentability, and creativity issues in artificial intelligence, Information Security Journal: A Global Perspective, volume 31., Issue 4., 2022](#)
- lix [House of Lords Library: Artificial intelligence: Development, risks and regulation, 18/07/23](#)
- i [The Economist: How to worry wisely about artificial intelligence, 20/04/23](#)
- ii [Grace, K., What do ML researchers think about AI in 2022, AI Impacts, 2022](#)
- iii [Financial Times: Open AI chief says new rules are needed to guard against AI risks, 16/05/23](#)
- liii [Harris, S. \(2023\) *The Trouble with AI*. 07/03/23.](#)
- liv [Harris, S. \(2023\) *Making Sense of Artificial Intelligence*. 22/11/22](#)
- lv FT Weekend Magazine April 15/16, 2023, pp.20-27
- lvi Russell, S.J. (2020) *Human compatible: Artificial Intelligence and the problem of Control*. London: Penguin Books.
- lvii [Harris, S. \(2023\) *The Trouble with AI*. 07/03/23.](#)
- lviii [UK Government: National AI Strategy, 2021](#)
- lix [UK Government: UK Science and Technology Framework, 2023](#)
- lx [UK Government: AI regulation: a pro-innovation approach, 2023](#)
- lxi [Department for the Economy: 10X Economy – an economic vision for a decade of innovation, 2021](#)
- lxii FT Weekend Magazine April 15/16, 2023, pp.20-27
- lxiii [Financial Times: Open AI chief says new rules are needed to guard against AI risks, 16/05/23](#)
- lxiv [Gizmodo: G7 Summit Leaders Call for Stricter AI 'Guardrails', 20/05/23](#)