The Alan Turing Institute – Written evidence (AIC0139)

The Alan Turing Institute makes this submission as part of the inquiry lodged by the House of Lords Select Committee on Artificial Intelligence.

The Alan Turing Institute is the UK’s national institute for data science. Five founding universities – Cambridge, Edinburgh, Oxford, UCL and Warwick – and the UK Engineering and Physical Sciences Research Council created The Alan Turing Institute in 2015. Our goals are: to undertake world-class research in data science, apply our research to real-world problems, driving economic impact and societal good, lead the training of a new generation of data scientists, and shape the public conversation around data. Our researchers come from a wide variety of intellectual and disciplinary backgrounds, ranging from computer science, statistics, and mathematics, to social sciences. To reflect this, answers to questions are attributed to individual authors, and opinions may not always align. We also encourage the Committee to consider this evidence alongside that submitted by our five founding universities.

The pace of technological change

Question 1: What is the current state of artificial intelligence and what factors have contributed to this? How is it likely to develop over the next 5, 10 and 20 years? What factors, technical or societal, will accelerate or hinder this development?

Theo Damoulas (Turing Fellow):
1. AI will continue to rapidly advance over the next decades in both an inward direction (towards Strong AI/Artificial General Intelligence) and an outward direction (impacting science, industry, society, governance). These directions are complementary and create fertile ground and a positive feedback loop for AI advancement.
2. AI is already leading a revolution in analysing, understanding and optimising operations and governance in our cities. Many research initiatives under the umbrella themes of “smart cities”, “urban informatics”, “computational social science” and “data science centres” have sprung up around the world (MIT, NYU, Warwick, Glasgow, Santa Fe, The Alan Turing Institute, IBM, Microsoft, etc.) over the last 5 years. Areas that were traditionally in the remit of the social sciences such as understanding social/group behaviour and policy evaluation are and will continue to be transformed by AI.
3. In the next decades we will move from evidence-based policy informing to more active and integrated human-machine policy making and control. As we continue to improve our sensing capabilities of social systems, our algorithms and statistical models, our computational capabilities and AI systems, we will be able to understand better these complex, dynamic, non-stationary systems. This will create unique advantages and opportunities for the social systems and governments that will reach this exciting nexus point. The UK has a unique advantage in reaching that point first through national initiatives such as The Alan Turing Institute, and a rapidly developing research capability in universities.

Simon DeDeo (Visiting Researcher at The Alan Turing Institute):
4. Artificial intelligence is the use of computers to predict, make decisions, and take action in the absence of explicitly-specified rules from a human programmer. While computers have been used to aid in complex decision-making for decades, they've mostly done so by implementing human-coded decision rules. As such, these older machines fall victim to what Alan Turing referred to as "Lady Lovelace’s Objection": they could do only what we could
specify in advance. The fly-by-wire system in a commercial aeroplane of the 1980s is an example of a non-AI system: while it is enormously complex, its audited if-then structure is not fundamentally different from the feedback loop of a thermostat.

5. Artificial intelligence is a fundamental advance on these older systems. Increases in computer power, new algorithms, and vast amounts of data have brought a new kind of machine into being. These systems make decisions on the basis of rulesets that have not been specified in advance. Advances in machine learning amount to discovering particularly fertile ways to constrain the space of rules the machine has to search, or in finding new and faster methods for searching it. As heuristics are stacked on top of heuristics, the downside can be to make the rules more tangled and harder to interpret than before.1

6. It is recent developments in computer power that make the benefits of AI apparent: the same algorithms run on 1950s, or even 1990s-era computers, would be intellectual curiosities. Paired with 21st Century technology, however, they have the potential to transform the material, social, and political landscape; as economists, political scientists, philosophers, and workers in the field itself often suggest, they have the potential to alter the basic rhythms of human life in a fashion last seen at the beginning of the Industrial Revolution.

Ricardo Silva (Turing Fellow):

7. We expect to see a bigger role of autonomous systems in experimenting with their environment for the benefit of users. We already observe this phenomenon in modest ways, such as in websites that optimise their users’ experiences by suggesting and presenting different combinations of website configuration, learning by observing the users’ reactions. We shall see such systems gaining an increasing role on assisting scientists, engineers and managers in new discoveries and ways of solving their short-term and long-term tasks. For that to succeed, machines must be able to better communicate their way of thinking when engaging in problem solving, and professionals should learn to play to the strengths of machine-made suggestions.

Maria Liakata (Turing Fellow):

8. Natural Language Processing (NLP) is a field closely linked to artificial intelligence that studies computational methods for automatically identifying structure in human language, in order to perform various tasks.2 These tasks assume some knowledge of language and range from relatively simple ones such as automatically recognizing entities in a text, to much more complex, yet fundamental ones, such as inferring the syntactic or semantic relations in a sentence (parsing), or automatically translating a text from one human language to another (machine translation). Technologies like Google translate, with which we interact every day, are based on NLP technology. Recent advances in deep learning have made us much better at addressing these tasks, as long as we have access to large amounts of data.

Question 2: Is the current level of excitement which surrounds artificial intelligence warranted?

Adrian Weller (Turing Fellow):

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2 See Jurafsky and Martin 2009
9. Recent advances in perception from deep learning are justifiably causing excitement, much of which is due to increased computing power and larger data sets. These trends are likely to continue, with significant energy and resources currently being invested into developing these further. Even if further development of these is slow, there are likely be great benefits of using this increased computing power and data sets to improve medical diagnosis and transport planning. However, there are misconceptions among the general public about the narrow limits of current AI systems. We are still a long way from a general learning system with human-like intelligence that can acquire knowledge from one domain and apply that flexibly in others. Certainly researchers are actively working on these challenges, and it is conceivable that we are not many years away – but we might easily be many decades away.

Maria Liakata (Turing Fellow):
10. Both AI and Natural Language Processing are moving at a fast pace, and in the next few years it is possible we will have trained computational models that are much better at making use of context and background knowledge, and diverse sources of linguistic and other information such as images, to allow better inference mechanisms and common sense reasoning. This will allow us to automatically interpret faster and draw more sophisticated conclusions. However, researchers in this area are also increasingly concerned about introduction of biases in the data. Problems stemming from the latter were famously depicted by Microsoft’s chat robot Tay, which was supposed to learn to speak in the language of a teenager, based on data posted to it by humans, but ended up being shut down as it was learning to swear and propagate dangerous views.

Impact on society

Question 3: How can the general public best be prepared for more widespread use of artificial intelligence?

Helena Quinn (Policy Officer):
11. Data science skills are likely to continue to grow in demand. In parallel, businesses will need to be data literate in order to take advantage of artificial intelligence. The Alan Turing Institute offers breakfast briefings and executive education to businesses to help fill this gap in data literacy amongst senior business figures. The general public would benefit from online training and much greater emphasis on numerical and computing skills from school level and onto university, and training students from non-mathematical and physical sciences effectively in quantitative methods.

Josh Cowls (Data Ethics Researcher):
12. The Alan Turing Institute is delighted to be partnering with the Nuffield Foundation on the recently announced Convention on Data Ethics, set to launch in 2018. The Convention will serve as a focal point for representatives of all sectors of society to collaboratively tackle the core ethical challenges posed by the rise of artificial intelligence, while engaging the public with these debates and their implications.

Question 4: Who in society is gaining the most from the development and use of artificial intelligence and data? Who is gaining the least? How can potential disparities be mitigated?

Maria Liakata (Turing Fellow):
13. AI can lead to a very useful set of tools that could help us advance as a society. We could be better researchers and scientists by having more advanced search and information extraction mechanisms; it could help us look after the environment through more efficient use of sensor information; it could allow better understanding of health problems and help provide cures by combining diverse sources of information and offer cost beneficial and regular monitoring of health conditions, providing extra evidence to doctors in their assessment; it could help us govern our countries more democratically by allowing access to multiple views and better understanding of people’s stance to various policies; it could help provide diverse means for education and training in various fields; it could help reduce the amount of bureaucracy and routine jobs, allowing us to be more creative with our time and focus on important endeavours. However, for all this to happen we need to have highly educated citizens who can comprehend the benefits of this technology and make the most of it rather than being passive consumers. I think there is a serious danger in focusing on cost benefits from AI and compromising on human training. It is a mistake to be replacing jobs without promoting education; we need human experts rather than relying on systems as the experts. To improve our experience as a society it is important to invest in education to have citizens that can make the most of the new technology in their everyday life and improve human-human interaction.

Public perception

Question 5: Should efforts be made to improve the public’s understanding of, and engagement with, artificial intelligence? If so, how?

Ricardo Silva (Turing Fellow):

14. One way of demystifying the use of AI is to see it as a toolbox for scaling up our potential. It fits the historical trend of using machines to solve tasks that otherwise would not be feasible or too costly. The real danger is society as a whole failing to train people to take new roles, not that we will run out of human potential. Access to proper training and information on how to make use of such resources is what the public should look forward to, what they should be incentivized to do, and what should be democratized.

Nathanaël Fijalkow (Research Fellow):

15. The issue of trust from the general public induces the most important challenge for the years to come: to make artificial intelligence trustworthy. To achieve this goal, the government can help in two different ways. First, it can, mobilise researchers and practitioners around a number of aspects crucial to the development of usable technologies: privacy, security, reliability, transparency. Great results have been obtained through research in understanding the mechanisms behind artificial intelligence. We need an increased effort to make this technology usable. Second, it can set standards, helping and encouraging companies to use artificial intelligence in a safe and responsible manner.

Industry

Question 6: What are the key sectors that stand to benefit from the development and use of artificial intelligence? Which sectors do not?

Ricardo Silva (Turing Fellow):
16. AI will move to change more specialized, knowledge-rich, jobs. As a concrete example, we should expect major advances in data-centric engineering, where intelligent systems will help in the design and monitoring of many complex systems. The scope of this enterprise will be massive, varying from the facilitated creation of energy-efficient technology to the design of smart urban infrastructure, sensitive to disaster management and prevention. Engineers should be trained early on how to maximise their potential by engaging with intelligent systems design tools.

Nicolas Guernion (Director of Partnerships):
17. AI, and in particular machine learning, also sometimes referred to as 'soft AI', has the potential to transform all economic sectors, from retail with the development of more powerful recommender systems which can better address customer needs, through to insurance where it can enable more accurate risk prediction (such as via analysis of satellite images or applications of voice analytics), health and well-being (early prediction of disease), finance (fraud detection applications) and law enforcement (faster text data analysis).

18. Whilst all sectors stand to benefit from AI and data science, there are vast inequalities in how fast economic sectors can reap the benefits from advances in this fast-moving field. Some of the largest sources of inequalities are access to trained people in the field and infrastructure and data readiness. Large corporations such as Google, Apple, Facebook and Amazon (GAFA), as well as companies leading the gig economy revolution (e.g. Uber, Airbnb, etc.) are able to recruit the best and often price out the competition. Finance and retail are also building up their capabilities at a fast pace, leaving huge gaps which cannot easily be filled in other sectors, such as traditional manufacturing. Lack of infrastructure and data readiness in some sectors also compound this issue e.g. farming, bulk manufacturing.

Question 7: How can the data-based monopolies of some large corporations, and the ‘winner-takes-all’ economies associated with them, be addressed? How can data be managed and safeguarded to ensure it contributes to the public good and a well-functioning economy?

Simon DeDeo (Visiting Researcher at The Alan Turing Institute):
19. Privileged access to massive data sets in private hands is a basic source of power for corporations like Google, Facebook, and Amazon, and there are current incentives for that data to be highly restricted. A visitor to the data centres of a company such as Google is immediately struck by the extreme levels of security in place, in some cases comparable to what one might expect at a nuclear power plant. Theft of information from these databases is, under the current legal system, economically catastrophic.

20. But these restrictions are completely artificial and may be neither just or fair. The data that comprises such a large part of Google’s or Facebook’s stock of capital was created by the users of that system. Companies get this data almost invariably free-of-charge, from ordinary citizens – at best in implicit exchange for services such as a free e-mail address or social media identity. Yet opting out of an e-mail address or, increasingly, a LinkedIn or Facebook account, is no longer possible if one wants to hold a job. As argued by a number of researchers in the field, such as the virtual reality pioneer Jaron Lanier, citizens may well have an expectation that they can reap the value of their own labour in more direct forms.

21. This becomes even more clearly apparent when, for example, a company like Uber considers using the records of its drivers to train an AI system that will replace them, or Google uses the publicly available translations from the European Union’s parliament to
train automatic translation systems that then replace the people that created the translations in the first place.

22. Data monopolies may not only be unfair and unjust, but also economically counterproductive: there is enormous value to the human race to be uncovered by disinterested investigation into proprietary data streams by scientists and the general public – not to mention competing corporations. And the need for companies to protect their data against theft is liable to become an increasing liability for economic stability. One solution to these linked questions of justice, innovation, and economic stability is to consider a data-sharing "patent" system, or term-limited monopoly comparable to the patent system for inventors. Such a "data patent" system would have to reward both the companies that assembled these databases, and, crucially, the individual users that participated in their construction. Although it could be based on the inventor's patent, it would have to go beyond it in novel and innovative ways, including the possibility of cash micropayments or annuities to citizens who provided the eyes, hands, and minds that trained a company's algorithms.

Maria Liakata (Turing Fellow):

23. The potential positive outcomes of AI could become a problem for society if access to AI technology and the data which feeds into AI systems were available to or controlled by very few. For example, while personal computers have been main-stream for the past 15-20 years and most people would be responsible for their own data we are moving to a time where data is stored somewhere on the cloud and computers are merely virtual machines. This would mean that we are giving away a lot of personal freedom to whomever controls these technologies. To prevent this from happening we need the government or organisations trusted by the public rather than large monopolies to be handling this technology. Even better, individuals should be able to control and make use of their own data. For example, this would be invaluable in personalized health monitoring, where individuals would decide who has access to their data and the technology that automatically processes their data.

24. The government could help against technology monopolies by large corporations by providing better incentives to smaller companies, making work at Universities and the public sector more appealing, and better funding research and technological development in public organisations. Another possibility would be to promote crowd-funding and longevity for open source projects as well as clarity in terms of the potential gains for citizens.

Ethics

Question 8: What are the ethical implications of the development and use of artificial intelligence? How can any negative implications be resolved?

Ricardo Silva (Turing Fellow):

25. Some AI systems will be required to run experiments with human subjects, which may be of unclear ethical viability. For instance, when testing pedagogical approaches with children in an intelligent tutoring program, or choosing environmental controlling procedures that may affect users' mood, it may be tempting to make the procedure as least intrusive as possible. However, we must ensure that appropriate permission for such experiments is obtained from the individuals concerned, and that the request for permission is communicated in a clear and unambiguous way.
Adrian Weller (Turing Fellow):

26. As AI systems are increasingly used to help make important predictions or decisions affecting our everyday lives (e.g. criminal sentencing, hiring decisions), we must take care to ensure that appropriate levels of trust in these systems are justified. This requires that we consider issues of fairness, transparency, privacy, reliability, security and value alignment. For any particular application, various groupings of these issues will be important in different ways. Hence, while we support calls for overarching principles, it will be important also to examine how these might apply in specific contexts. As one example, the use of personal data to decide health insurance premia worries many people, whereas a similar use to decide what to charge for car drivers’ insurance seems reasonable to many.

27. By fairness, we should like to ensure that algorithms will not discriminate against any particular subgroup of the population. If we train a machine learning system to emulate past biased human decisions (for example in making hiring decisions), we are implicitly training the system to replicate previous human bias. In addition, developers may simply overlook the potential for difficulties, as evidenced in Google’s early image recognition system which mistook people with dark skin for gorillas. Further, there are more subtle potential problems of bias: suppose a bank is deciding whether or not to make a loan to an individual, requiring some minimum threshold level of certainty that the loan will be repaid before deciding to make the loan; if there is simply not much data available on a particular sub-population, then the algorithm will not predict a sufficiently high enough level of certainty even if the individual might otherwise represent a sound bet. Fairness in machine learning is a rapidly developing field of research so that even if we only have biased training data, still we can hope to enforce fairness constraints so that a learned system will behave in an appropriate manner.

28. Many machine learning approaches learn from a set of training data, aiming to achieve low average performance error on test data which is assumed to come from the same distribution. However, in real-world applications, we shall often require a much greater level of robustness. For example, autonomous vehicles must perform well across all weather scenarios, even those which might never have been seen previously. There are many technical challenges which must be addressed.

Question 9: In what situations is a relative lack of transparency in artificial intelligence systems (so-called ‘black boxing’) acceptable? When should it not be permissible?

Ricardo Silva (Turing Fellow):

29. The power of machine learning on exploiting data as a way of avoiding explicit programming does not mean it can compensate for limitations in the data. Lack of transparency is manageable if the gaps in the data are known not to be of major importance as in, for instance, the informal use of machine translation. In fact, there is no such a thing as a complete dataset: data will contain biases and gaps that are absorbed and filled up by methods having varying degrees of transparency. The less well understood the data is as a means to achieve a particular goal, the more important transparency will be. One should not decouple transparency from data quality assessment.

Adrian Weller (Turing Fellow):

30. Transparency if often helpful, but it is not a universal good— see “Challenges for Transparency”, Weller, 2016. There are cases where it may be essential – for example, if AI is used to help decide criminal sentencing, an intelligible explanation of the reasoning should be provided to demonstrate that appropriate process was followed and to enable
meaningful challenge. Transparency is sometimes a proxy for what is really required, such as reliability or fairness, and it may be more efficient to try to improve those end goals directly. Actors with misaligned interests can abuse transparency leading to a worse outcome (for example, gaming of a system). In some cases, transparency must be considered in tension with privacy requirements.

The role of the Government

Question 10: What role should the Government take in the development and use of artificial intelligence in the United Kingdom? Should artificial intelligence be regulated? If so, how?

Brad Love (Turing Fellow):
31. The Government has a constructive role to play in the development and use of artificial intelligence as it does with other emerging technologies. However, it could be detrimental to treat AI differently than any other promising technology that is steadily improving. Policy and regulations should be informed by the realities and practicalities of this technology, rather than alarmist voices.
32. Existing laws and regulations may adequately cover AI. For example, currently, an aircraft manufacturer would be liable for a malfunctioning autopilot system that led to a loss of life. If, instead, the autopilot were "artificially intelligent", which systems developed decades ago could be considered, the same responsibilities would hold. We already have laws that cover faulty products, as well as the release of computer code (e.g., viruses) that are intended to harm the general public.
33. Specific regulation of AI would be difficult to craft as there is no firm line dividing AI from non-AI approaches. AI and machine learning approaches are continuous with standard engineering and statistical approaches. What was once considered AI, like product scanners in the supermarket, are now commonplace. Insurance firms use complex statistical models to evaluate risk and policy premiums. Should these techniques be considered AI?
34. If a guideline could be established, it would be very difficult to determine whether an AI system was in compliance. In complex AI systems, it is not always clear why a system made the decision it did, which parallels difficulties in determining the bases of performance in human experts. One active area of research in AI is trying to understand the bases of performance in AI systems, much like how Experimental Psychologists continue to examine the bases for human performance.
35. AI specific regulation could reduce innovation and competitiveness for UK industry. Consider a corporation developing an AI smoke detector that was designed to use context to be more sensitive to actual fires while avoiding false alarms. Such a system could save lives and inconvenience, but the competitive benefit in the market could be overshadowed by additional regulatory burden. Like the autopilot example above, existing laws and testing standards regulating such products should prove satisfactory. Finally, the UK is only one nation amongst many competitors. Innovation will likely take place where government is supportive and adopts a measured approach, as has proved to be the case with autonomous vehicles.

Adrian Weller (Turing Fellow):
36. AI presents tremendous opportunities for all of society. Government can help build on our nation’s strengths as a world leader in research and business through: increased funding for basic research; nurturing a thriving environment for start-ups and responsible business; education; and encouraging involvement of people with diverse backgrounds. Yet AI also
presents important concerns, which we should address thoughtfully with appropriate governance. We support calls for a stewardship body to consider the long term governance of AI systems, their applications and their impact on society.

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