Written evidence from the Royal Statistical Society to House of Lords Select Committee inquiry on the implications of Artificial Intelligence

The Royal Statistical Society (RSS) is a learned society and professional body for statisticians and data analysts, and a charity which promotes statistics for the public good. We have around 8000 members in the UK and around the world, and our key strategic goals support the use of statistics and data in the public interest, education for statistical literacy, strengthening the discipline of statistics, and development of the skills of statistical professions. The RSS has a Data Science Section, and hosts a network focused on machine learning.

Summary

There is huge potential for society to benefit from the application and development of artificial intelligence (AI), data science and statistics. There is clearly scope for further and future growth in AI, driven by new technologies and applications, and by exponential growth in the volume and variety of digital data. The government's priorities in its industrial strategy green paper suggested to us some important avenues for the future development of AI, and we are pleased to develop the following recommendations with regard to your independent Inquiry.

- To increase the opportunities presented by AI, we need to strengthen recruitment into AI and related fields. There is a need to strengthen the UK's skills base for this, particularly our nation's quantitative skills. We support the recommendation by Professor Sir Adrian Smith of a study of the long-term implications of the rise of data science for education and skills, allied with support for greater participation in mathematical education.
- While increasing national investment in science and research, we need to shore up research capabilities for AI and related disciplines. We look to the new UKRI to prioritise capabilities in statistics, data science and AI, as well as fundamental mathematical research, and to break down silos between research councils for multidisciplinary work in these areas. The Alan Turing Institute's activities could also expand to support a much wider network of research and teaching in support of data science across the UK.
- Data infrastructure should be a priority as it is a basis for the data economy. Arrangements for data access, local data and open data can be strengthened, and data protection regulation – including the adoption of the EU's General Data Protection Regulation and our subsequent approach within domestic legislation – will be crucial to AI and related fields.

With the growth of digital data there is also, however, growing scope for failure in how such data are accessed and used. To help establish a trusted basis for action across all of the above activities, we recommend:

- Stronger deliberation on questions relating to data ethics. We are working with the Nuffield Foundation and others to create a new Convention on Data Ethics which will help to explore the new ethical challenges posed by AI, machine learning and data science.
- Support for public engagement with regard to data science and artificial intelligence. Without effective public deliberation, conclusions cannot readily be drawn on public views, particularly about the uses of personal data and the desired benefits of such uses.
- Development of professional standards for data science, and application of ethical principles. Professional bodies should also take a lead on developing standards, and the RSS's Data Science Section is willing to play its part in this.

Evidence in full

1. Public perception

1.1. Data and algorithms are fundamental to our economy and to people's day to day lives. For example, global consultancy firm McKinsey estimate that $2.8 trillion was contributed to global GDP from data flows in 2014 (compared to $2.7 trillion from flows of goods) [1]. The volume and variety of data that could be made available for analysis has exponentially grown, and developments in statistics, data science and artificial intelligence will be essential to make good uses of these new sources of data.

1.2. In an age when data-driven technologies and industries are growing at a furious rate, one key limit placed on public understanding and participation in AI will be access to the appropriate level of education, skills and experience. In their reporting on the global economy, McKinsey have recognised that very few of the countries participating in global data flows have adequately supported their workers and communities to participate as the economy changes, and they strongly recommend developing clearer paths to new roles [2]. For the UK to be a global leader in AI and machine learning, we need a stronger quantitative skills base. The RSS supports, in our *Data Manifesto*, the strengthening of education and training pathways, to ensure that preparation for statistical and data literacy is widened in school, and continues in colleges and universities and into the world of work.

1.3. Initiatives with young people will be important for the future, and will need to address some concerning deficits of participation in key subject areas. The recent review of post-16 mathematics in England by Professor Sir Adrian Smith (the Smith Review) was prompted by evidence and concern that the proportion of students who choose to continue to study mathematics after the age of 16 is much lower in England, Wales and Northern Ireland than it is in other comparable countries [3].

1.4. RSS's own view is that to meet the future needs of industry relating to data science, machine learning and AI, young people need not only have a strong mathematical and statistical education but also strong practical experience of digital and data analysis, and that all should get the chance to analyse real data using technology. Greater participation in this at all levels would support the use of data in the economy and in society, and would help to diversify employment in the science and technology sector. New 'core maths' qualifications for England are a development which we particularly support, as these should boost participation among students who would not otherwise continue to study mathematics post-16.

1.5. A wealth of other evidence for a digital skills gap has also been published, for example in the House of Commons Science and Technology Committee's report on the 'Digital Skills Crisis', which recommended that "the Government needs to establish an effective pipeline of individuals with specialist skills in data science, coding and a broader scientific workforce that is equipped with a firm grounding in mathematics, data analysis and computing [4]." The Smith Review has further recommended that the Government should commission a study into the long-term implications of the rise of data science, to look at the skills that are required for the future [5]. The RSS would be supportive of action on this, alongside actions that support quantitative education and access to jobs in the data economy.

2. The role of government

2.1. We welcome the commitment made to research and innovation in the UK's industrial strategy, which will add £4.7 billion in investment before 2020-2021. However, the sources and provision of research funding will undergo changes, following the formation of UK Research and Innovation (UKRI) and the UK's exit from the European Union. As these changes take place, the UK needs to shore up its position in AI and related disciplines: the overall number of graduates from mathematical science degrees (undergraduate and postgraduate) has declined, and mathematics, statistics and computation have been listed as 'vulnerable capabilities and skills' within the UK's bioscience and biomedical research base. We look to the new UKRI to prioritise research capabilities in data science and AI, and in the mathematical sciences that underpin them, on a cross-cutting basis across all disciplines. It could ensure that there is national support for this across the UK's research and innovation system, to an extent that individual research councils are unable to do.

2.2. National investment in AI and data science may benefit from review. Jo Johnson, the Minister of State for Universities, Science, Research and Innovation, has highlighted the UK's concentration of public investment in the 'golden triangle' (which refers to leading universities in London, Oxford and Cambridge) [6]. The Alan Turing Institute has been established in London with a focus on data science. The RSS would be supportive in principle of expanding the scope of the Alan Turing Institute's activities to a much wider network of research and teaching institutes, to be a truly national supporter of data science and AI. In parallel with developing the UK's skills base, strong and sustainable international avenues for recruitment into research, teaching and training need to be maintained, to ensure that access to talent is not unnecessarily affected by Brexit.

2.3. The quality of data that is accessed and used for AI is easily obscured but forms a crucial basis for new developments. There is much that can be done to strengthen data infrastructure that supports new technology and innovation. We can access new sources of data for statistics on the economy and other domains, with data sharing across government and from the private sector enabled in the Digital Economy Act 2017. Greater access could be afforded to local data, and more could be done to release open data. There is also an enormous range of new *sources* of data coming into play, such as sensor technology and connected appliances, which could soon be widely applied in a variety of fields, including energy, transport, cities, and healthcare. The UK's data protection regulation – its adoption of the EU's General Data Protection Regulation and its subsequent approach within domestic legislation – will be crucial to AI and related fields.

3. Ethics / Impact on society

3.1. Research that the RSS commissioned from Ipsos MORI in 2014 found a 'data trust deficit' among members of the public, who trusted organisations to a lesser extent on how they handle their data than they trust them generally [7]. The Government Office for Science has highlighted the range of potential benefits from adopting artificial intelligence (AI) and machine learning, which include making public services more efficient by anticipating demand and tailoring their provision, and making decisions more transparent [8]. However, to more fully realise these benefits, there is a need to address public concerns. Even those uses that are on balance well regarded by the public, such as the use of data for beneficial medical and public health research, can be badly affected by loss of trust.

3.2. Further research in this area points to a need for caution when widening the field of application for unexplained / partially explained data science and AI, from less regulated industries where they may have been developed, to those that require much greater explainability. We see important differences in the level of pressure to explain data science and statistical approaches across different industries. Developments in medicine and in clinical trials, for example, have become increasingly regulated to reduce potential harm, whereas other industries such as advertising, entertainment and online social media platforms are much more lightly regulated, and might remain so. The divergence between fields can lead to problems: Google DeepMind for example has said of its arrangement for data sharing from the Royal Free Hospital: *'we underestimated the complexity of the NHS and of the rules around patient data, as well as the potential fears about a well-known tech company working in health. We were almost exclusively focused on building tools that nurses and doctors wanted, and thought of our work as technology for clinicians rather than something that needed to be accountable to and shaped by patients, the public and the NHS as a whole. We got that wrong, and we need to do better.'* [9]

3.3. With the growth of digital and data infrastructure there is growing scope for failure in how such data are accessed and used. For important societal applications (e.g. in the labour market, for access to jobs or for appraisal of performance) we believe there should be scope for appeal by members of the public who may be badly affected, as well as scope for the organisations that use such algorithms to evaluate the decisions that were taken and on what basis. Transparent and defensible statistical outputs should ideally be the end goal of innovation in these areas. In circumstances where this is not the case, developments should have a level of explainability in mind to avoid key failures for their industry and for service users. It is important for existing law (e.g. anti-discrimination) to develop through the courts to manage newly arising challenges. [10]

3.4. The RSS has long suggested the establishment of a body to take forward thinking on data ethics in the UK. In autumn 2015, we held a workshop on the opportunities and ethics of big data, and suggested formation of a national council for data ethics to the Science and Technology committee, who then made it a recommendation in their Big Data Dilemma report [11]. The idea of a data ethics body has been gaining momentum ever since. The Conservative Party's 2017 election manifesto committed to setting up a Commission on the Use and Ethics of Data, and a report from the Royal Society and British Academy has recommended a new stewardship body for data governance [12]. The Nuffield Foundation, RSS, Alan Turing Institute, Royal Society, and British Academy are engaged in a partnership to take forward thinking in this area [13].

3.5. Deliberation is particularly important, as approaches to transparency and accountability will not be adequately addressed by legislation. Researchers from UCL Big Data Institute for example consider that transparency cannot be guaranteed and that sometimes the power of machine learning models may mean that a lack of transparency is justified:

> *"Modern machine-learning algorithms are typically designed to excel in predictive accuracy using massive volumes of data. The availability of extremely large datasets, together with modern computational power, makes this approach quite practical. However, with prediction as the endpoint, such algorithms tend to assimilate the input data and construct complex models with convoluted and interacting components. [...] It thus becomes difficult to unpick specific strands of the decision-making process to understand precisely how a conclusion was reached. By contrast, traditional statistical algorithms are concerned with*

explanation as well as prediction, and tend to use clearly specified, often linear models, which are easier to scrutinise –although they are, on occasion, less powerful. In some cases, the impressive performance of ML algorithms can make the lack of transparency a reasonable trade-off, but this may not always be the case." (Olhede & Rodrigues, 2017 [14])

3.6. Stronger public engagement will be needed. In connection with their review of governance for data management and use, the British Academy and Royal Society reviewed public dialogues and engagement in the UK over the past ten years regarding the collection, sharing and use of personal data. Public awareness of new uses of data, such as machine learning, is found to be low, and they find that very few studies have investigated public attitudes to new and future uses of data: "While some studies have explored potential near-term applications of data technologies, none so far have looked into future worlds enabled by data […] While several studies have looked into what criteria people use to define what is considered a valuable and beneficial output of data, they have not looked in depth at the social and ethical values at stake nor at the tensions between public good and personal risk." [15]

3.6. New thinking on the application of ethical principles can also be driven forward by learned societies and professions. Data science is relatively young as a profession, with few professional standards. The application of ethics should be better understood, with strong ethical training embedded into data science courses, so that data scientists can anticipate issues including with the data that they train their algorithms on. Professional bodies should also take a leading role in developing standards, and the Data Science Section of the Royal Statistical Society is willing to help in this regard.

[1] Box 3. Valuing cross-border data flows' in Manyika, J. Lund, S. Bughin, J. Woetzel, J. Stamenov, K. Dhingra, D. (2016) *Digital globalization: The new era of data flows* [PDF], McKinsey Global Institute. http://www.mckinsey.com/~/media/McKinsey/Business%20Functions/McKinsey%20Digital/Our%20Insights/Digital%20globalization%20The%20new%20era%20of%20global%20flows/MGI-Digital-globalization-Full-report.ashx

[2] 'Box 4. The impact of global flows on employment' in Manyika *et al.*, *ibid.*

[3] Nuffield Foundation (2010) *Is the UK an outlier? An international comparison of upper secondary mathematics* http://www.nuffieldfoundation.org/sites/default/files/files/Is%20the%20UK%20an%20Outlier_Nuffield%20Foundation_v_FINAL.pdf, cited p. 29 in *Report of Professor Sir Adrian Smith's review of post-16 mathematics* ['The Smith Review'] [PDF], July 2017 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/630488/AS_review_report.pdf

[4] House of Commons Science and Technology Select Committee (2016) *Digital skills crisis* [PDF], https://publications.parliament.uk/pa/cm201617/cmselect/cmsctech/270/270.pdf

[5] The Smith Review, *ibid*, p. 14

[6] Department for Business, Innovation and Skills and Jo Johnson MP (2015) 'Speech: one nation science' [webpage] https://www.gov.uk/government/speeches/one-nation-science ;

Higher Education Statistics Agency (2017) Income and expenditure by HE provider 2015/16 and 2014/15 (Table 1) [XLSX]. https://www.hesa.ac.uk/data-and-analysis/providers/overviews?year=620&topic%5B%5D=606

[7] ‘RSS research finds ‘data trust deficit’, with lessons for policymakers’ [webpage], *StatsLife*, 22 July 2014. https://www.statslife.org.uk/news/1672-new-rss-research-finds-data-trust-deficit-with-lessons-for-policymakers

[8] Government Office for Science (2016) *Artificial intelligence: opportunities and implications for the future of decision making* [PDF] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/566075/gs-16-19-artificial-intelligence-ai-report.pdf

[9] DeepMind (2017) ‘The information commissioner, the Royal Free, and what we’ve learned’ [webpage], 3 July 2017, https://deepmind.com/blog/ico-royal-free/

[10] Royal Statistical Society (2017) ‘The use of algorithms in decision making: RSS evidence to the House of Commons Science and Technology Select Committee Inquiry’ [webpage]. http://www.rss.org.uk/Images/PDF/influencing-change/2017/RSS%20evidence%20on%20the%20use%20of%20algorithms%20in%20decision%20making%20April%202017.pdf

[11] The Royal Statistical Society (2016) *The Opportunities and Ethics of Big Data: Report of a consultation run by St George’s House in November 2015 in association with The Royal Statistical Society, supported by the British Academy and SAGE* [PDF] http://www.rss.org.uk/Images/PDF/influencing-change/2016/rss-report-opps-and-ethics-of-big-data-feb-2016.pdf

Recommendation 14 in ‘The big data dilemma: Government Response to the Committee’s Fourth Report of Session 2015–16’ [webpage], 26 April 2016. Commons Select Committee > Science and Technology. https://www.publications.parliament.uk/pa/cm201516/cmselect/cmsctech/992/99204.htm

[12] British Academy and Royal Society (2017) *Data Management and Use: Governance in the 21st Century* [PDF] http://www.britac.ac.uk/sites/default/files/Data%20management%20and%20use%20-%20Governance%20in%20the%2021st%20century.pdf

[13] ‘Convention on Data Ethics’ at Nuffield Foundation [website] » News » ‘Nuffield Foundation announces additional £20 million research funding, Fellowship programme, and major data ethics initiative in new five-year strategy’ http://www.nuffieldfoundation.org/news/nuffield-foundation-announces-additional-%C2%A320-million-research-funding-fellowship-programme-and-

[14] Olhede, S. Rodrigues, R. (2017) ‘Fairness and transparency in the age of the algorithm’, *Significance*, 5 April 2017. http://onlinelibrary.wiley.com/doi/10.1111/j.1740-9713.2017.01012.x/full

[15] p. 4 in British Academy & Royal Society (2017) *Data governance: public engagement review* [PDF], https://royalsociety.org/~/media/policy/projects/data-governance/data-governance-public-engagement-review.pdf