1. Department for Business, Energy & Industrial Strategy (https://www.gov.uk/government/organisations/department-for-business-energy-and-industrial-strategy)
2. Department for Digital, Culture, Media & Sport (https://www.gov.uk/government/organisations/department-for-digital-culture-media-sport)

Policy paper

AI Sector Deal

Updated 21 May 2019

Contents

This publication is available at https://www.gov.uk/government/publications/artificial-intelligence-sector-deal/ai-sector-deal

Foreword

Throughout history, there have been moments when the progress of technology has taken great steps forward, when a combination of the right tools, a capacity for innovation, and sparks of ingenuity lead to breakthroughs that transform how we live our lives.

How we produce and process information is critical to innovation – and our methods of recording and communicating information have themselves undergone great leaps. From the development of writing, to Gutenberg's printing press – which advanced the spread of knowledge to the masses and ushered in the enlightenment and scientific revolution – to the first programmable digital computer Colossus, the cost of reproducing and communicating information, or data, has fallen again and again. At the same time, tools for processing and making sense of large quantities of data have developed exponentially – with artificial intelligence (AI) representing the latest leap. In the same way that Gutenberg's press ushered in a new era of growth, data-driven technologies such as AI will underpin our future prosperity.

There is no doubt that machine learning and AI is already improving peoples' lives, from intelligent personal assistants that can prepare us for changes in the weather, to systems that protect our money from criminals, or devices that offer medical advice from the comfort of our own home. And this is only the start; the potential of AI is undeniable. Our next challenge will be to harness this technology to transform how we diagnose diseases, manufacture goods and build our homes.

Using advanced algorithmic techniques such as 'deep learning', AI has the potential to solve complex problems fast, and in so doing, free up time and raise productivity. But we also need to make sure AI benefits everyone in the UK, which is why – in addition to this Sector Deal – the government is establishing a Centre for Data Ethics and Innovation to advise on the ethical use of data, including for AI.

The huge global opportunity AI presents is why the Industrial Strategy white paper (https://www.gov.uk/government/publications/industrial-strategy-building-a-britain-fit-for-the-future) identified AI and data as 1 of 4 Grand Challenges – in which the UK can lead the world for years to come.

The UK is well placed to do this. We are already home to some of the biggest names in the business such as Deepmind, Swiftkey and Babylon.

And it's not just the established players – Kwiziq, Cleo and Mindtrace are examples of UK AI startups leading the way in areas as diverse as education, personal finance and autonomous vehicles. Major established companies in the tech sector, but also increasingly beyond, are using AI to tune up their operations and services.

To realise all the social and economic benefits, we will need a strong partnership between business, academia and government. This sector deal establishes the beginning of that partnership. It responds to the recommendations of the AI Review, 'Growing the AI Industry in the UK' (https://www.gov.uk/government/publications/growing-the-artificial-intelligence-industry-in-the-uk), led by Professor Dame Wendy Hall and Jérôme Pesenti, which articulated how the government and industry can work together on skills, infrastructure and implement a longterm strategy for AI in the UK.

We need to be strategic and focused: recognising the increasing convergence of technologies and focusing on the areas where we can compete globally.

While robotics, a complementary technology to AI, was outside the scope of the AI Review, recommendations on the robotics industry have been made in the Robotics Review RAS 2020 (https://connect.innovateuk.org/documents/2903012/16074728/RAS%20UK%20Strategy?version=1.0), and in 'Made Smarter' (https://www.gov.uk/government/publications/made-smarter-review), a review on digitising the manufacturing industry. Moving forwards, identifying and making the most of these synergies will be crucial for success.

A revolution in AI technology is already emerging. If we act now, we can lead it from the front. But if we 'wait and see' other countries will seize the advantage. Together, we can make the UK a global leader in this technology that will change all our lives.

Rt Hon Greg Clark MP (https://www.gov.uk/government/people/greg-clark)
Secretary of State for Business, Energy and Industrial Strategy

Rt Hon Matt Hancock MP (https://www.gov.uk/government/people/matthew-hancock)
Secretary of State for Digital, Culture, Media and Sport

Professor Dame Wendy Hall (http://users.ecs.soton.ac.uk/wh/)
Regius Professor of Computer Science, the University of Southampton

Jérôme Pesenti (https://research.fb.com/people/pesenti-jerome/)
Vice President of AI, Facebook

Industrial Strategy at a glance

We will create an economy that boosts productivity and earning power throughout the UK.

5 foundations of productivity

The Industrial Strategy is built on 5 foundations:

- Ideas - the world’s most innovative economy
- People - good jobs and greater earning power for all
- Infrastructure - a major upgrade to the UK’s infrastructure
- Business environment - the best place to start and grow a business
- Places - prosperous communities across the UK

Grand Challenges

We will set Grand Challenges (https://www.gov.uk/government/publications/industrial-strategy-the-grand-challenges/industrial-strategy-the-grand-challenges) to put the United Kingdom at the forefront of the industries of the future:

- AI and Data Economy - We will put the UK at the forefront of the artificial intelligence and data revolution
- Future of Mobility - We will become a world leader in the way people, goods and services move
- Clean Growth - We will maximise the advantages for UK industry from the global shift to clean growth
- Ageing Society - We will harness the power of innovation to help meet the needs of an ageing society

Key policies

Key policies include:

Ideas

- Raise total research and development (R&D) investment to 2.4% of GDP by 2027
- Increase the rate of R&D tax credit to 12%
- Invest £725 million in new Industrial Strategy Challenge Fund programmes to capture the value of innovation

People

- Establish a technical education system that rivals the best in the world to stand alongside our world-class higher education system
- Invest an additional £406 million in maths, digital and technical education, helping to address the shortage of science, technology, engineering and maths (STEM) skills
- Create a new National Retraining Scheme that supports people to re-skill, beginning with a £64 million investment for digital and construction training

Infrastructure

- Increase the National Productivity Investment Fund to £31 billion, supporting investments in transport, housing and digital infrastructure
- Support electric vehicles through £400 million charging infrastructure investment and an extra £100 million to extend the plug-in car grant
- Boost our digital infrastructure with over £1 billion of public investment, including £176 million for 5G and £200 million for local areas to encourage roll out of full-fibre networks

Business environment

- Launch and roll out Sector Deals – partnerships between government and industry aiming to increase sector productivity. The first Sector Deals are in life sciences, construction, artificial intelligence and the automotive sector
- Drive over £20 billion of investment in innovative and high potential businesses, including through establishing a new £2.5 billion Investment Fund, incubated in the British Business Bank
- Launch a review of the actions that could be most effective in improving the productivity and growth of small and medium-sized businesses, including how to address what has been called the 'long tail' of lower productivity firms

Places

- Agree Local Industrial Strategies that build on local strengths and deliver on economic opportunities
- Create a new Transforming Cities fund that will provide £1.7 billion for intra-city transport. This will fund projects that drive productivity by improving connections within city regions
- Provide £42 million to pilot a Teacher Development Premium. This will test the impact of a £1,000 budget for high-quality professional development for teachers working in areas that have fallen behind

An independent Industrial Strategy Council will assess our progress and make recommendations to government.

Executive summary

Creating an economy that harnesses artificial intelligence (AI) and big data is one of the great opportunities of our age.

This Sector Deal is the first commitment from government and industry to realise this technology's potential, outlining a package of up to £0.95 billion of support for the sector, which includes government, industry and academic contributions up to £603 million in newly allocated funding, and up to £342 million from within existing budgets, alongside £250 million for Connected and Autonomous Vehicles. This support complements and leverages some of the £1.7 billion that has been announced under the cross-sectoral Industrial Strategy Challenge Fund so far, with 5 challenges having AI components that AI businesses will be able to bid into through future competitions.

This Sector Deal sets out actions to promote the adoption and use of AI in the UK, and delivers on the recommendations of the independent AI review, 'Growing the AI industry in the UK', led by Professor Dame Wendy Hall and Jérôme Pesenti[1]. Their review, published in October 2017, engaged widely with businesses, academia, investors and other stakeholders on ways to boost the UK's emerging AI sector at home and across the world. It sets out proposals to improve the institutions that support AI in the United Kingdom, to build a skilled workforce, and to stimulate access to data – collectively the lifeblood of any AI business.

This Sector Deal reinforces the 5 foundations of the Industrial Strategy:

- ideas
- people
- infrastructure

- business environment
- places

It also draws on the government's Digital Strategy (https://www.gov.uk/government/publications/uk-digital-strategy), which focuses on reinforcing our strengths in telecoms, data and enterprise. A key ambition of the industrial strategy is for the UK to be the world's most innovative economy – this Sector Deal aims to attract and retain both domestic and global AI talent; deliver major upgrades to our digital and data infrastructure; ensure that the UK is the best place to start and grow an AI business; and contribute to communities' prosperity by spreading the benefits of AI across the country.

People

The Industrial Strategy has people at its core: it is focused on creating good jobs and greater earning power for all people in the UK. To do this, we must equip citizens for jobs shaped by next generation technology. Growing the AI industry in the UK outlined the fast-growing demand for expertise to develop and apply AI technologies, and proposed ways to increase the supply of skills at different levels. Building on these recommendations and the commitments in the Industrial Strategy and Digital Strategy to grow science, technology, engineering and maths (STEM) and digital skills training, this Sector Deal sets out how the government, universities and industry will work together to greatly improve the supply of skills. It also sets out how we will attract the best, and most diverse, global AI talent to the UK.

Infrastructure

Ensuring the UK has the right digital infrastructure – both physical and, crucially, data infrastructure – is critical to meeting our ambition of leading the world in AI. That is why, as part of our Industrial Strategy, we are investing over £1 billion to create a country with world class digital capabilities: from 5G mobile networks to full-fibre broadband. Equally important is the availability of data, which is required on a vast scale to train machine learning systems. The government and public bodies are already leading the way in making public datasets open and available. But there remain significant challenges to sharing private sector datasets. Through this Sector Deal, we will tackle both the practical and cultural barriers to sharing both publicly and privately held data. As part of this we will explore data sharing frameworks such as Data Trusts – mechanisms where parties have defined rights and responsibilities with respect to shared data – in order to protect sensitive data, facilitate access to data, and ensure accountability. This will allow and ensure fair and equitable data sharing between organisations in the private sector, and between the private and public sectors.

Ideas

The government set out a vision in the Industrial Strategy to make the UK the world's most innovative economy. To achieve this, we are committing to work with the private sector to boost research and development (R&D) spending to 2.4% by 2027, and 3% over the longer term. This begins with a £725 million investment through the Industrial Strategy Challenge Fund competition, designed to capture the value of innovation by commercialising a great idea in the lab to a successful business. For example, one early commitment is our £210 million Challenge on research into the early diagnosis of chronic illness – including a substantial investment in AI diagnostics techniques[2]. The use of AI is central to this work, which includes programmes applying AI to raise output in sectors of the economy that have struggled with productivity, from reducing crop disease in the agriculture sector, to delivering services digitally in the public sector. We are seeing industry respond to our commitment to AI innovation with investments in R&D in the UK, such as those from major players like Beyond Limits and Element AI.

Business Environment

Our intention is to be the best place to start and grow a business in the world. With a new business starting up every 75 seconds in the UK, and a massive increase in the finance available to knowledge-intensive and innovative firms – such as those developing AI – through the British Business Bank, we are in a strong starting position.

As at September 2017, over £350 million[3] has been invested in 243 technology companies through the British Business Bank's venture capital programmes.

AI is emerging in its own right as a nascent industry with the potential to raise the productivity of diverse sectors and create entirely new jobs. To maximise this potential, this deal will establish a new AI Council to bring together respected leaders in the field from across academia and industry; a new delivery body within the government – the Office for Artificial Intelligence – to support it; and a new Centre for Data Ethics and Innovation. The deal will also increase promotion of AI businesses globally and take steps to attract AI entrepreneurs to the UK. A recent report by Oxford Insights ranked the UK top for government readiness to implement AI, and these measures will allow us to capitalise on the UK's worldclass R&D and tech entrepreneur base[4].

Places

The Industrial Strategy set out the goal of helping communities prosper throughout the UK. Growing the AI industry in the UK outlined the thriving AI ecosystem that already exists. London is the European capital of AI, while significant clusters exist in places such as Edinburgh, Belfast, Bristol and Cambridge. As important as the growth of these clusters of expertise is, our ambition is for AI to be adopted by businesses across the country. This deal will help businesses around the UK to grow using AI, and is supported by the government's backing for the expansion of Tech City UK (https://www.techcityuk.com/) and Tech North (https://technorthhq.com/) into the national network Tech Nation, alongside its Scale Up campaign. At the same time, we are expanding the academic commitment to AI across the UK as universities partner with The Alan Turing Institute (https://www.turing.ac.uk/), the national institute for data science and AI.

Case Study: QuantumBlack – from startup to scale-up

QuantumBlack is a British tech company using machine learning and artificial intelligence "in the wild" to help clients in the government, corporate, and third sectors increase their performance. The teams include data engineers, data scientists, and designers. Now a British 'scale-up' story, QuantumBlack has grown from its early days in Formula One racing, where the 3 founders met, to 350 technology experts in the UK head office and also in Boston, India and Australia. The thriving London tech and talent scene, as well as the UK's leading universities, have been pivotal in this growth story.

Grand Challenge

Growing the UK's AI & data-driven economy

We are at the cusp of one of the most exciting times in our lives, and if we get our strategy for AI right, then we will be able to reap the rewards for our economy for decades to come.

The Industrial Strategy set out 4 Grand Challenges (https://www.gov.uk/government/publications/industrial-strategy-the-grand-challenges/industrial-strategy-the-grand-challenges) where the UK must act now to put itself at the forefront of the industries that will shape our futures and have a transformative impact on society. Through the Grand Challenges we are committed to taking advantage of major global trends, improving people's lives and working in partnership with business and academia.

One of these is for the UK to maximise the economic and societal benefits of the current global technological revolution. We recognise that AI will transform the way we live and work, from the way we diagnose and treat cancer to the security of online transactions. It can realise the potential for higher productivity and new jobs in nearly every sector in every country.

This Sector Deal will ensure we seize this global opportunity, and is focused on the recommendations put forward by Professor Dame Wendy Hall and Jérôme Pesenti to promote AI businesses in the UK.

But we will go further, setting out a vision of how the UK can respond to the broader opportunities and challenges for society posed by AI, including by:

- making the UK a global centre for AI and data-driven innovation by investing in R&D, skills and regulatory innovation
- supporting sectors to boost their productivity through artificial intelligence and data analytics technologies
- leading the world in the safe and ethical use of data through a new Centre for Data Ethics and Innovation, and strengthening the UK's cybersecurity capability
- helping people develop the skills needed for the jobs of the future through investment in STEM skills and computer science teachers, as well as retraining and researching the impact of automation across sectors

Key commitments

Ideas

To be the world's most innovative economy.

Government action to support AI

Support AI innovation to raise productivity:

- Invest up to £20 million in the application of AI in the services sector through the Next Generation Services Industrial Strategy Challenge. This will include a network of Innovation Research Centres and collaborative R&D to develop new applications of AI and data-driven technologies in sectors such as law and insurance[5].
- Invest £93 million from the Industrial Strategy Challenge Fund into the robotics and AI in extreme environments programme, towards the research and development of robotics and AI technologies for use in industries such as offshore and nuclear energy, space and deep mining, with the aim of supporting safer working practices for people in extreme environments that could prevent potential harm and increase productivity.
- The government will work with academia, the broader research community, industry and end users to integrate AI into future Industrial Strategy Challenge Fund challenges.

Stimulate uptake of AI, including within the public sector:

- Create a £20 million GovTech Fund, supported by a GovTech Catalyst, which will support tech businesses to provide the government with innovative solutions for more efficient public services and stimulate the UK's growing GovTech sector.

- Raise overall UK R&D intensity by raising total R&D spending across public and private sectors to 2.4% by 2027, and 3% over the longer term.
- Increase in the rate of the R&D Expenditure Credit from 11% to 12% from January 2018.

EPSRC support for AI

- £300 million has been allocated by the EPSRC to fund research related to 'data science and AI' complementing the new centres for doctoral training.
- £83 million EPSRC funding for 159 AI grants listed under the EPSRC Research Area Artificial Intelligence Technologies.
- £42 million EPSRC funding for the Alan Turing Institute, with £30 million funding from partners: Lloyds Register, Intel, and ARM.

Industry action to support AI

Invest in AI-related R&D to boost productivity:

- Industry will provide match funding for AI solutions across key sectors: services, life sciences, agriculture and the public sector.
- Recognise the UK's strengths in AI by backing it as a country to invest in, as seen through recent major investments.
- Up to £12 million of anticipated industry funding to support the Next Generation Services Industrial Strategy Challenge.
- Commit to £69 million of industry funding to support the development of robotics and AI in extreme environments.

Investments in the UK from AI powerhouses

Google	DeepMind and its parent, Alphabet's Google, are global leaders in AI. Google currently has 3 offices in London, with a new HQ planned for King's Cross that will house 7,000 staff when it opens in 2020.
Element AI	Element AI is an artificial intelligence solutions provider that was co-founded in October 2016 by established entrepreneur Jean-François Gagné and leading AI researcher Yoshua Bengio. With deep domain expertise and access to cutting-edge technology, it focuses on turning AI research into transformative business applications and will open a new R&D centre in London in 2018.
Amazon	Amazon has expanded its headcount in the UK to 24,000, including the opening of a new head office and doubling the number of roles at its London Development Centre, bringing Amazon's total corporate and R&D workforce in London to approximately 5,000 by the end of 2017. The company has also announced plans to open two further robotics enabled fulfilment centres.
HPE	HPE, Arm, SUSE, and the universities of Bristol, Edinburgh and Leicester will invest into Catalyst UK, a 3 year programme to establish one of the largest Arm-based supercomputer deployments to accelerate deployment of artificial intelligence available to both academia and industry across the UK.

Beyond Limits	Beyond Limits is a private company based in Glendale California spun-out of JPL – part of NASA, and a leading software developer – to commercialise 20 years of investment in next generation cognitive reasoning AI. This software has been deployed successfully by NASA, the US military and other government agencies for fully autonomous systems that can 'think outside the box' and handle new situations, even where there is little or no data. Beyond Limits has chosen the UK for its international base for global expansion centred around the Cambridge area where there is a deep pool of AI and data science talent.
Ironfly Technologies	Ironfly Technologies is a rapidly growing startup headquartered in Hong Kong that uses AI and machine learning to interact with live market data to generate bespoke analytics for the financial sector. Having recently established a base in London, it is looking to expand its London team of product developers.
Astroscale	Japanese company Astroscale will develop a world leading capability in AI technology for cleaning up space debris and in orbit satellite servicing in the UK, which is expected to generate over 100 high-value engineering jobs in the UK within five years. This will be backed with over $20 million from Astroscale to build a supply chain with a significant amount of that investment in the UK, and is supported by £4 million from the Robotics and AI in Extreme Environments Industrial Strategy Challenge Fund.
Chrysalix	Top-ranking Vancouver based venture capital firm Chrysalix, is establishing its European HQ in the UK. A strong investor in AI and robotics, Chrysalix expects to invest 40 to 60% of its latest $250 million fund through its European base. Chrysalix is also engaging UK universities and centres of excellence to bring business challenges to the academic world and to connect new inventions with the business world.

People

To generate good jobs and greater earning power for all.

Government action to support AI

Work with schools, universities and industry to ensure a highly-skilled workforce:

- Develop a prestigious global Turing Fellowship programme to both attract and retain the best research talent in AI from around the world to the UK, to include individuals already based here. This will put the infrastructure in place to train future generations of AI talent.
- Build towards an additional 200 doctoral studentships in AI and related disciplines a year by 2020 to 2021, raising numbers year-on-year into the next decade. By 2025, we will have at least 1,000 government supported PhD places at any one time.
- The AI-relevant studentships will be distributed via the current EPSRC call for Centres in Doctoral Training, which will be supported with £100 million investment from government.
- Invest £406 million in skills, with a focus on maths, digital, and technical education, including funding to upskill up to 8,000 computer science teachers and creating a National Centre for Computing. We have also committed to introduce a National Retraining Scheme this Parliament,

with an initial investment in construction and digital skills while the scheme is being developed.
- The government will refer to The Alan Turing Institute's upcoming reviews on the application of AI to sectors in the UK to inform future strategic thinking on the adoption of AI in industry and government.

Enable access to high-skilled global talent:

- Doubled Tier 1 (Exceptional Talent) visas to 2,000 a year to attract the best and brightest talent in science, digital technology (including specialists in AI), engineering, arts and creative sectors.
- Work with Tech Nation to explore how to promote this and other visa routes to AI specialists.
- Changed immigration rules to enable world-leading scientists and researchers arriving under the Tier 1 (Exceptional Talent) route to apply for settlement after 3 years.
- Made it quicker for highly-skilled students to apply to work in the UK after finishing their degrees, and reduce red tape in hiring international researchers.

Take steps to promote diversity in the development of AI:

- The government will work with the AI Council to promote the importance of a diverse research base and workforce in AI.

Industry action to support AI

Invest to increase the size of the AI workforce:

- Work with universities to develop industry-funded Masters programmes in AI, based at leading universities across the UK.
- Work with government and universities to assess the potential role for new Masters conversion courses in AIrelated expertise, for skilled graduates in other disciplines.
- Commit an estimated £60 million funding towards the AI-relevant doctoral studentships, which will be distributed by the EPSRC call for Centres in Doctoral Training.
- Support the Turing Fellowship scheme for AI, to keep and foster the best researchers in the UK and internationally.
- Sage is running a pilot programme for 150 under-18s across the UK, to encourage them to think about a career in the AI sector. The 'Sage FutureMakers Labs' will teach a broad range of skills required to work in the field of AI - including machine learning, natural language processing, problem solving and other cognitive techniques, as well as an understanding of the ethical considerations that surround AI. The aim is to show the leaders of tomorrow that AI is a career choice open to all that can be accessed through classroom or on-the job learning.

Work to increase the diversity in the AI workforce:

- Commit to increasing the diversity in the AI workforce and support efforts to address this, led by the AI Council.

Infrastructure

To drive a major upgrade to the UK's infrastructure.

Government action to support AI

Enhance the UK's existing data infrastructure:

- Build on the UK's strength in data infrastructure by taking steps to publish more high quality public data in an open, easily findable and reusable format suitable for machine learning.
- Establish the Geospatial Commission to determine how best to improve access to geospatial data to a wider range of users, including businesses using and innovating with AI technologies.
- Provide legal certainty over the sharing and use of data in accordance with the UK's strengthened Data Protection Bill.
- The Alan Turing Institute and the Information Commissioner's Office will work together to develop guidance to assist in explaining AI decisions.

Develop fair, equitable and secure data sharing frameworks:

- Work with major data holders in both the private and public sectors, along with the data science community, to identify barriers to sharing data.
- Work with industry to explore frameworks and mechanisms for safe, secure and equitable data transfer such as Data Trusts.

Deliver a strong digital and telecommunications infrastructure across the UK:

- Reach 95% superfast broadband coverage.
- Invest over £1 billion to develop 5G mobile networks and extend full fibre broadband to build the next generation digital infrastructure.

Industry action to support AI

Work towards interoperable and, where possible, open data standards:

- AI developers to enhance and define technical standards that allow interoperability between AI systems, and collaborate with the government on a framework of standards to underpin this.
- AI developers to engage with government on their digital and data infrastructure requirements.
- Publish identified trends and findings from use and analysis of public data openly to strengthen our data infrastructure.

Partner in the development of data sharing frameworks:

- Businesses, academia and other expert organisations as holders and users of data to participate in developing data sharing frameworks such as Data Trusts.
- Businesses to come forward with use cases for publicly held data that can be shared securely when the frameworks are piloted.

Strengthen and deliver telecommunications and digital infrastructure:

- Telecommunications companies to offer competitive delivery of full fibre and 5G.
- AI industry to work with telecommunications providers on specific needs for AI-supportive telecommunications infrastructure.

Business environment

To be the best place to start and grow a business.

Government action to support AI

Develop policy to support AI in the UK:

- The government will use its convening power to establish an AI Council of leading figures from industry and academia with ministerial representation. The Council will drive action, oversee implementation of the deal, galvanise industry, and advise government.
- The government will establish a new Office for Artificial Intelligence to work with the AI Council to create and deliver the AI strategy, and collaborate with other relevant initiatives, such as the GovTech Catalyst.

Promote UK Artificial Intelligence globally:

- The government will work closely with the new AI Council to expand export and investment support for AI businesses in the UK including through promoting AI businesses at trade missions.
- The government will increase its export support for innovative AI and data businesses, and the Global Entrepreneur Programme will look to increase its focus on attracting AI and data-led businesses to establish headquarters in the UK.

Improve the environment for high growth businesses, including in AI:

- Establish a new £2.5 billion Investment Fund incubated in the British Business Bank. By co-investing with the private sector, a total of £7.5bn of investment will be supported.
- Expand significantly the support available to innovative knowledge-intensive businesses through reforming the Enterprise Investment Scheme (EIS) and Venture Capital Trusts (VCTs), realising over £7 billion of new investment into high growth businesses over the next 10 years.
- Work with the Pensions Regulator to clarify investment guidance for trustees to give pension funds confidence that they can invest in assets supporting innovative businesses as part of a diverse portfolio.

Industry action to support AI

Leadership, policy setting and strategy:

- Senior figures from industry and academia will participate in the AI Council to provide high level leadership and momentum for the implementation of AI review recommendations and the Sector Deal.
- Industry will work closely with the government, through the AI Council, on broader questions related to AI such as data ethics and the role of AI in the public sector.

Promotion of AI in the UK and globally:

- Industry will continue to develop the broader ecosystem that will drive trade and attract AI investment to the UK, including through participating in trade missions, AI exhibitions and international conferences.

Improve the environment for start-ups:

- Global Brain, one of the largest venture capital firms in Japan with $700 million under management, is opening its first European HQ in the UK, with plans to deploy £35 million over 5 years in UK deeptech startups, with a key focus on AI, Blockchain and Robotics, as well application areas such

as Cybersecurity, Cloudtech, Fintech, Aerospace and Healthtech. They will support companies with investment as well as business development within Japan, for instance by connecting investees to large corporate customers.
- Hewlett Packard Enterprise recently announced new offerings to help customers ramp up, optimise and scale AI usage across business functions to drive outcomes such as better demand forecasting, improved operational efficiency and increased sales.

Places

To have prosperous communities throughout the United Kingdom.

Government action to support AI

Work closely with key clusters to provide the support needed for AI businesses to thrive:

- Invest £21 million in Tech City UK over 4 years, to become Tech Nation and support regional tech companies and startups to fulfil their potential.
- Invest over £1 billion in next generation digital infrastructure to ensure the whole of the UK is digitally connected.
- Support The Alan Turing Institute's plans for expansion to become the national academic institute for artificial intelligence and data science.
- Work with Digital Catapult centres across London, North East & Tees Valley, Northern Ireland, Brighton and Yorkshire to help implement digital policies and identify policy needs in emerging technologies.
- Ensure that the views of the devolved administrations are represented in the AI community through engagement with the new Office for AI.

Industry action to support AI

Take action to expand AI clusters across the UK:

- BT is collaborating with Ulster University by investing in a new £29 million AI R&D cluster that aims to attract and retain industrial engineers and university researchers.
- Leading semiconductor specialist IQE is to invest £38m alongside Cardiff University to develop a compound semiconductor facility that will manufacture high performance components used in AI applications as part of the £1.2 billion City Deal agreed between local authorities, and the Welsh and UK governments.
- Barclays has launched the bank's first Scottish 'Eagle Lab' in Edinburgh in a new partnership with CodeBase, the UK's largest tech incubator, to help businesses scale-up - including AI businesses.
- Startups nationwide will make use of the Digital Catapult's 'Machine Intelligence Garage' programme to access specialised hardware and expertise affordably, and drive adoption of AI across the UK.

Ideas

Support AI innovation to raise productivity

Our vision in the Industrial Strategy - for the UK to be the world's most innovative economy - is supported by a very significant increase in R&D spending between the government and industry. This will boost R&D spending to 2.4% of GDP by 2027, and 3% over the longer term, beginning with a £725 million investment in new Industrial Strategy Challenge Fund programmes to capture the value of innovation. This is part of a broader commitment to raise total public investment in R&D from around £9.5 billion in 2016 to 2017 to £12.5 billion in 2021 to 2022.

This Sector Deal positions the Artificial Intelligence sector to play a growing role in meeting this ambition – with a potential contribution of £200 billion or 10% of UK GDP by 2030[6]. The government, industry and academia will co-invest to drive R&D in AI including through the Industrial Strategy Challenge Fund. Industry recognises this commitment to innovation: already some of the most R&D intensive startups are basing themselves here such as Beyond Limits and Element AI.

It's not just the startups who are investing. Rolls-Royce has signed a Memorandum of Understanding with the Alan Turing Institute to codesign and deliver a programme of collaborative research in data science and AI. In particular, jointly-run research projects will explore: how data science can be applied at scale, the application of AI across supply chains, data-centric engineering and predictive maintenance, and the role of data analytics and AI in science.

Stimulate uptake of AI within the public sector

As announced in the Industrial Strategy white paper (https://www.gov.uk/government/publications/industrial-strategy-building-a-britain-fit-for-the-future), the government will invest £20 million in GovTech initiatives that will improve the delivery of public services, from transport and the environment, to education and health. We will also bring together existing work across central government and public bodies to share these technologies and understand how they are deployed most successfully.

Investments in the UK from AI powerhouses

Many of our most successful businesses started life as an idea in a university lab here in the UK. As the home of 4 of the top 10 universities in the world, we are a magnet for the highest calibre researchers in artificial intelligence and related disciplines.

DeepMind, a prominent UK-based AI firm developed out of our leading universities, not only created AlphaGo, (the programme that defeated the world's greatest player of Go, a fiendishly complex board game) but created a new version which taught itself to defeat the original programme. Alphabet, the parent company of Google and DeepMind – and a world leader in AI – is building a new headquarters in London that will be home to 7,000 staff: a significant vote of confidence in the UK's strength in R&D.

Amazon is similarly building its UK base, increasing its staff by almost a fifth in 2017 to 24,000, including a major expansion of its R&D workforce to around 1,500. This includes a new development centre in Cambridge (the company's second in the city), to add to existing development centres in Edinburgh and London.

The UK has also produced other globally recognised AI firms such as Improbable, which specialises in using AI for virtual reality (VR), and has developed simulation technology with the potential to model the behaviour of millions of people. In 2017, Japanese telecommunications corporation SoftBank invested $500 million in Improbable, raising the value of the startup to over $1 billion. Onfido, which was founded 5 years ago to make identity verification checks quicker and easier for businesses, has developed machine learning technology used by businesses all over the world to help hire staff more quickly and easily.

Most recently, we have also seen notable investments in the UK from global AI firms including Ironfly Technologies, a Hong Kong-based startup that uses machine learning in financial services and Element AI, an artificial intelligence solutions provider, which is opening a new R&D centre in London in 2018.

We are confident that the measures announced through this Sector Deal, alongside the government's vision to be a leader in meeting the challenges posed by AI and data, will lead to further major investments in UK AI from businesses around the world.

Case Study: STFC-IBM ideas for an intelligent future

Science and Technology Facilities Council (SFTC) and IBM Researchers, as part of the Hartree Centre, in Daresbury, are collaborating on projects with multiple industrial and government research organisations in the UK. Exploiting AI methods, they are creating reusable digital assets including: in machine learning and in uncertainty quantification to greatly increase productivity through mechanical and experimental design, intelligent control of complex systems, and to speed up modelling and simulation – which will lead to enhanced competitive advantage in a variety of areas ranging from fast moving consumer goods, advanced materials and molecular discovery, to even waste water treatment. The Hartree Centre is able to leverage the wider STFC and IBM Research organisations to provide additional capability for its clients including the Hursley and Rutherford Appleton Labs.

People

Work with schools, universities and industry to ensure a highly-skilled workforce

Skilled experts are needed to develop AI, and they are in short supply. As a global leader, the UK needs a large workforce with deep AI expertise; a more diverse, AI research base and workforce; and better digital skills in the wider workforce to use AI.

Demand for AI talent in AI techniques, such as machine learning, is increasing rapidly. Action is needed now to ensure the skills pipeline can meet the needs of industry now and in the future. By one estimate, the market value of AI technologies is expected to increase at a compound annual growth rate of over 60% to 2022[7]. We must take concerted action or risk other countries seizing the opportunity and causing a brain drain from the UK.

In 2017 there were 26 UK universities offering undergraduate courses in AI and more than 30 graduate programmes running across 20 universities. Numbers of students have been rising modestly in recent years, driven predominantly by PhD level places (where the number of enrolments have almost doubled to just under 400 between 2013 and 2015[8]). A recent government consultation with AI academics highlighted the gap between supply and demand for university places, with one institution turning down 13 viable candidates per available masters place.

The government recognises that to provide the advanced skills needed for creating AI algorithms, the work begins in schools. That is why we have announced a major reform of technical education with the launch of T levels and investment in STEM subjects. We announced in the 2017 Autumn Budget £84 million of new funding to deliver a comprehensive 4 year programme to improve computing education and drive up participation in computer science, including upskilling up to 8,000 computer science teachers, to ensure there is a suitably qualified GCSE teacher in every school. The government has also

supported the creation of Ada, the National College of Digital Skills, which will train up to 5,000 students over the next 7 years for a wide range of digital careers. At a higher level, industry will be investing to fund a Masters degree programme with an integrated internship, targeting an initial cohort of 200 students per year. The government will be funding 450 new PhD places, and establishing a prestigious Turing Fellowship to support an initial cohort of 10 AI Fellows, to keep the best and brightest AI researchers in the UK. These are just the first steps that we are taking to ensure the growth of AI skills in the UK.

Case Study: ASI – Creating capability in tomorrow's leading scientists

ASI helps organisations develop capability in AI through a combination of expertise, technology and training. They run Europe's most prestigious programme for helping top STEM PhDs to transition into real world data scientists. Nearly 10% of the UK's STEM PhDs apply for their fellowship every year, and the programme has enabled British firms like easyJet, Babylon Health, Asos, Ovo Energy and Zopa to access the skills needed to build some of the most sophisticated AI capabilities in the world. ASI's in-house data science team use cutting edge machine learning expertise to help clients solve problems ranging from making trains run on time to detecting terrorist propaganda online. And all of this is powered by their data science platform, SherlockML, which has been developed to be the world's best environment for data scientists to efficiently develop and deploy artificial intelligence algorithms.

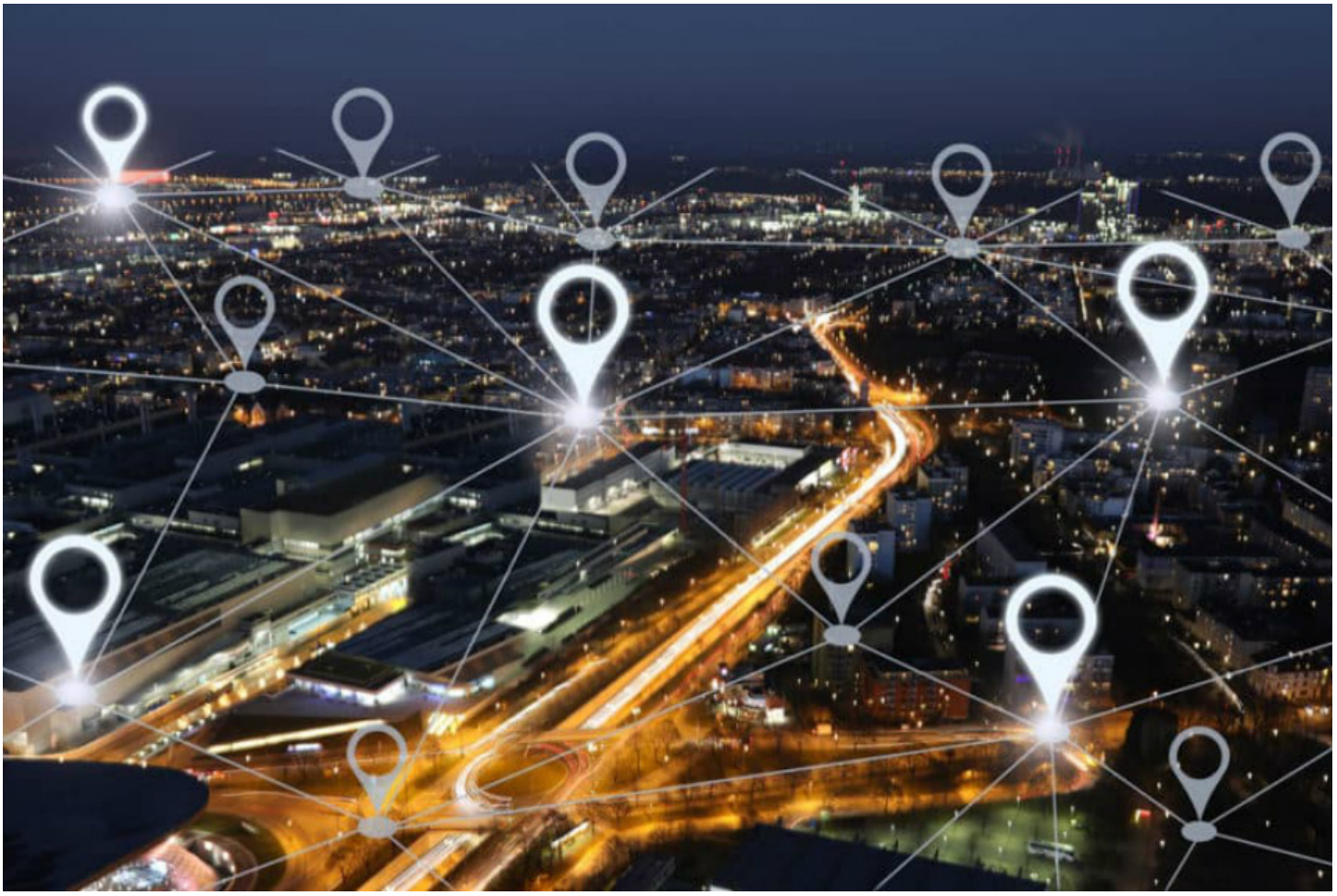
Enable access to high-skilled global talent

The government has doubled the number of available Tier 1 visas for 'Exceptional Talent' – including specialists in AI – from 1,000 to 2,000 per year. This presents a great opportunity to ensure the UK attracts the best and brightest talent in AI, alongside world leaders in science, digital technology, engineering, arts and creative sectors. We will work with Tech Nation to explore how to promote this and other visa routes to AI specialists to maximise the growth of AI in the UK.

Take steps to promote diversity in the AI workforce

Increasing diversity in the AI workforce is vital to ensure that everyone with the potential to participate has the opportunity to do so. It is essential that AI developed in the UK reflects the needs and make-up of society as a whole and that industry and the public sector are able to access the greatest supply of talent in terms of numbers. The government will work with the AI Council to promote diversity in the AI workforce.

Infrastructure



Enhance the UK's existing data infrastructure

Data is a critical part of our digital infrastructure – and fundamental to AI. It enables all kinds of services we use everyday from maps on our smartphones, to social media and payment processes. Without access to good quality data from a range of sources (whether privately or publicly held), AI technologies cannot deliver on their promise of better, more efficient and seamless services.

Open data published by organisations across a range of sectors have enabled other businesses to innovate and build new services, which in turn can make significant contributions to the economy. Transport apps such as CityMapper, for example, make journeys more efficient and have led to the creation of 'pop-up' bus routes for commonly made journeys that were previously unserved.

Similarly, open environmental data has been used to create flood risk and water quality apps. To test the autonomous vehicles of the future we will need good quality 3D topographic data on road conditions and roadside obstacles.

The government is committed to opening up more data in a way that makes it reusable and easily accessible. A good example is geospatial data. The Geospatial Commission announced in the 2017 Autumn Budget will provide strategic oversight to the various public bodies who hold geospatial data, seeking to maximise the growth of the digital economy and consolidate the UK's position as the best place to start and grow a digital business. To further boost the digital economy, the government is working with the Ordnance Survey (OS) and the new Commission to establish how to open up freely the OS MasterMap data to UK-based small businesses in particular. Geospatial data is a key enabler for AI technologies.

In addition, the eInfrastructure Advisory Board (eAB) has recently been set up by UKRI with the purpose of advising the CEO of UKRI on High Performance Computing (HPC) Research infrastructure, and will be developing an eInfrastructure development roadmap, as well as other HPC related projects, going forward.

Case study: Ocado – Machine learning to build a smart broadband of grocery

Ocado are the world's largest online-only grocery retailer, with over 600,000 active customers in the UK. As they are fully online, creating a robust data infrastructure and managing data effectively are both crucial to the success of the business. For example, in order to classify and prioritise the daily stream of emails into their call centre, Ocado has built a cloudbased machine learning model, which was trained on a database of 3 million emails previously classified by call centre agents.

Machine learning is also used to monitor the health of their robot swarms, which carry out the bulk of the work in their new automated warehouses. Here, data from the robots are streamed to a data lake where analytical systems oversee performance and identify servicing requirements. By programming machine learning into the robots themselves using technologies such as embedded Tensor Flow, this also creates opportunities for swarm learning, where the learnings of one robot can be shared with the rest of the swarm, a concept which will keep driverless vehicles responsive and agile when on the road.

These are just 2 examples of the many ways that AI and machine learning pervade Ocado's end-to-end e-commerce, fulfilment and logistics platform.

Develop fair, equitable and secure data sharing frameworks

Some of the most valuable data – in terms of its potential for enabling innovation, improving services of realising public sector savings – cannot be made open because it contains nationally critical, personal or commercially sensitive information. This includes data which could be used to identify individuals. Organisations looking to access or share data can often face a range of barriers, from trust and cultural concerns to practical and legal obstacles. To address these issues, we are working with industry to pioneer mechanisms for data sharing such as Data Trusts. These frameworks will ensure that all parties involved have defined rights and responsibilities towards the data and individuals' personal data, and other sensitive data, is protected. For example, the vision for Data Trusts is that they will allow 2 or more parties in any sector to partner in data sharing agreements, shape the agreements according to their needs and enable multiple organisations to work together to solve a common problem.

In addition to Data Trusts, we will explore how to improve data sharing generally, through sharing frameworks and consideration of data portability.

Deliver a strong digital infrastructure across the UK

The government will work with the telecommunications industry to extend coverage of superfast broadband across the UK, achieving a baseline speed of 24 Megabits per second (Mbps). More than £1 billion is being invested to develop 5G mobile networks and extend the full-fibre rollout, capable of providing a highly reliable connection and speeds exceeding 1 Gigabit per second.

In addition, the University of Cambridge Research Computing Service is making the UK's fastest academic supercomputer available to AI technology companies. This new AI supercomputer is a £10 million partnership between the Engineering and Physical Sciences Research Council (EPSRC), the

Science and Technology Facilities Council (STFC) and the university. Capable of solving the largest scientific and industrial challenges at very high speeds, it is supported by advice and consultancy from the team at Cambridge. The aim is to help companies to create real business value from advanced computing infrastructures.

In the 2017 Autumn Budget, the government announced a range of initiatives to ensure the infrastructure of the UK is wholly digitally connected. This included funding from the National Productivity Investment Fund to launch the £190 million Challenge Fund for Local Full Fibre Networks and provide a further £159 million for the 5G Testbeds and Trials programme. This will close down digital coldspots, ensuring AI businesses can thrive anywhere in the UK.

Business environment

Develop policy to support AI in the UK

Effective leadership and partnerships will be vital to driving forward AI in the UK. As part of the Sector Deal, the government will use its convening power to establish an AI Council as a central forum where industry, academia and government leaders can come together to identify opportunities and issues and actions to address them.

Similar partnerships have been successful in other sectors such as professional and business services, and the automotive industry.

This council will be supported by the new Office for AI, a delivery body tasked with implementing the Sector Deal and the government's overarching strategy for AI. Finally, a Centre for Data Ethics and Innovation will be tasked with ensuring safe, ethical and ground-breaking innovation in AI and data-driven

technologies.

Together, these new institutions will provide the governance and oversight of delivery of the Sector Deal and the wider Grand Challenge.

Promote UK Artificial Intelligence globally

The UK is a world leader in exporting innovation and technology. Our businesses serve customers all round the world in every sector. We have a fantastic opportunity to export our AI expertise too. The government is committed to helping our AI businesses succeed globally. It will increase its promotion of UK AI businesses through trade missions and take steps to attract AI entrepreneurs to the UK. It will look to increase its focus on attracting AI and data-led businesses to establish headquarters in the UK. And, as part of the government's broader commitment to increasing investment and exports, AI will benefit from the nine new Trade Commissioners responsible for leading export promotion, inward and outward direct investment, and trade policy overseas. The fruits of this effort are already showing – as demonstrated through the commitments by Element AI and others to establish bases in the UK. In addition, government's Venture Capital Unit has supported international companies – such as Global Brain, who committed to establishing their European HQ in London – and continue to work with venture capitalists looking to invest in the UK. Along with our commitments to a visa system that welcomes the best talent, we will establish the UK as the go-to place to headquarter an AI business.

Case study: DigitalGenius – A cutting-edge AI company on an export journey

DigitalGenius brings practical applications of artificial intelligence (AI) into the customer service operations of some major global businesses. Its customer service platform combines the best of human and machine intelligence, enabling businesses to live up to and exceed rising consumer expectations. The platform automates and increases the quality and efficiency of customer support across communication channels like email, chat, social media and mobile messaging.

A focus on exports has been a key part of the company's business plan from the start and – with the support of the government – has enabled DigitalGenius to grow from 20 to 60 employees in 1 year. Its software is currently powering over 30 contact centres around the world.

Improve the environment for high growth businesses, including in AI

The government is committed to making the UK the best place to start and grow a business. As an emerging sector, support for scaling up is particularly important for AI businesses where technology changes rapidly, funding rounds are frequent and the burn-rate high. The government is committed to improving the financing of growth in highly innovative businesses. To do this the government is:

- establishing a new £2.5 billion Investment Fund incubated in the British Business Bank
- investing in a series of private sector fund of funds of scale – the British Business Bank will seed the first wave of investment with up to £500 million, unlocking double its investment in private capital
- doubling the annual allowance for people investing in knowledgeintensive businesses through the Enterprise Investment Scheme (EIS) to £2 million a year
- providing greater flexibility for knowledge-intensive businesses over when they can access a first investment through EIS and Venture Capital Trusts (VCT)
- doubling the amount knowledgeintensive businesses can receive in a single year through EIS or VCT investment to £10 million

- backing first-time and emerging fund managers through the British Business Bank's established Enterprise Capital Fund programme unlocking at least an additional £1.5 billion of investment
- backing overseas investment in UK venture capital, expected to release £1 billion of investment
- supporting long-term investment by giving pension funds confidence that they can invest in assets supporting innovative businesses as part of a diverse portfolio
- changing the qualifying rules in Entrepreneurs' Relief to remove the disincentive to accept external investment and consulting on the detailed implementation of that change
- increasing the rate of the R&D expenditure credit from 11% to 12%

Places

Work closely with key clusters to provide the support needed for AI businesses to thrive

The government is committed to helping prosperous communities to thrive across the UK. As highlighted in 'Growing the AI industry in the UK', while the majority of AI businesses are based in London[9], there are a number of other major technology clusters around the UK.

Yet many places are not realising their full potential. By introducing Local Industrial Strategies, and further strengthening local leadership through Local Enterprise Partnerships and Mayoral Combined Authorities, we will provide incentives to make regions across the UK attractive environments for AI businesses and research to flourish in. The huge potential for AI to transform sectors means action is needed now so that new and existing clusters are equipped to support the growing demand for AI, and to be able to offer services locally.

For example, we are investing £21 million in Tech City UK over 4 years to expand into Tech Nation. Tech Nation will roll out dedicated sector programmes in tech specialisms, including AI. The AI programme will operate in 2 or 3 key clusters where there is AI expertise and potential to provide the mentoring and growth support needed for ambitious AI businesses to thrive. The aim is to link promising AI clusters into a powerful network of high growth AI businesses – part of Tech Nation's strategy of linking regional tech clusters in London, Cambridge, Bristol and Bath, Manchester, Newcastle, Leeds and Sheffield, Reading, Birmingham, Edinburgh and Glasgow, Belfast, and Cardiff, to create a world leading national network of high growth tech entrepreneurs in the UK.

Key to the UK realising the full economic benefit of AI is ensuring the adoption, deployment and use of AI technologies by organisations of all size and sector. Following a recommendation made in the AI Review techUK, the Royal Academy of Engineering and the Digital Catapult are working together to provide practical guidance and tools to support the effective and responsible use of AI by businesses across the UK. We are also working with Digital Catapult centres across London, North East and Tees Valley, Northern Ireland, Brighton and Yorkshire to help businesses adopt AI effectively.

Alongside the 5 founding partner universities (Cambridge, Edinburgh, Oxford, Warwick and University College London) and the Engineering and Physical Sciences Research Council, The Alan Turing Institute has begun a programme of accepting new university partners. 8 new university partners have been announced in recent months.

These and other universities based in all 4 nations of the UK with strengths in AI, will host prestigious Turing Fellowships, whose holders will also be based at the Turing Institute. This will enable the Institute's geographical span to grow and transform it into a truly national institute for AI and data science.

The actions we are taking to support the growth of AI ecosystems apply throughout the United Kingdom and the challenges we face are shared with our partners in the devolved administrations. As we deliver this Sector Deal we will look for opportunities to collaborate.

As the UK's longest established AI research centre, the University of Edinburgh has been the home for many spin-out businesses, such as Skyscanner, while the Edinburgh Centre for Robotics recently won a £36 million grant for research into offshore robotics. Additionally, data driven innovation and AI technologies underpin the £1.1 billion Scottish and UK government funded Edinburgh City Region Deal. Meanwhile, BT is opening a £29 million R&D facility in Belfast, and partnering with Ulster University to research future technologies such as the Internet of Things, AI, data analytics, cybersecurity and 5G. Welsh company IQE has been at the forefront of the compound semiconductor industry for more than 25 years, and has joined with Cardiff University to invest in developing a compound semiconductor cluster in the area as part of the £1.2 billion City Deal agreed between local authorities, Welsh and UK governments. This builds on the existing cluster in the region, which is supported by the UK government's investment in the Compound Semiconductor Applications Catapult. We want to support the growth of these clusters and the measures in the Industrial Strategy and Sector Deal will help achieve this.

Case study: BT – Supporting national growth through regional R&D partnerships

BT is funding AI research at 15 leading universities across the UK, and is the UK's largest telecoms and ICT investor in R&D. In addition, BT is leading a 5 year, £5 million partnership with the Universities of Lancaster, Cambridge, Surrey and Bristol, as part of EPSRC's £78 million Prosperity programme, creating an AI powered next generation data infrastructure for the UK. BT is expanding its global R&D centre and startup cluster at Adastral Park in East Anglia. Specifically, BT is committed to creating carrier scale and critical national infrastructure ready AI technology. This is an integral part of the evolving consortium of UK companies and institutions behind a proposed national Future Networks Research Centre with its hub at Adastral Park to drive AI into the global telecoms infrastructure.

Further information

Implementation plan

Key deal activities

Date	Milestone
October 2017	Publication of the AI Review
November 2017	Industrial Strategy white paper published Announcement of £20 million Industrial Strategy Challenge Fund (ISCF) support for Next Generation Services using artificial intelligence, and £210 million ISCF support for Data to early diagnostics and precision medicine which includes using AI to analyse medical images in digital pathology

Date	Milestone
Quarter 2 2018	Sector Deal launched Establishment of AI Council, interim Centre for Data Ethics and Innovation, and Office for AI First meeting of the AI Council First funded challenges are launched, including Next Generation Services
Quarter 1 2019	Annual Review of the Sector Deal

Governance

Oversight of the implementation of the Sector Deal will be led by the Office for Artificial Intelligence, which will review progress against objectives regularly.

The new government Office for Artificial Intelligence will be established with responsibility for implementing this Sector Deal. It will support the AI Council which will oversee and drive the implementation of the deal.

An early role for the Office for AI will be to agree implementation plans for each section of the deal, including agreed success metrics.

Membership of the AI Council will be announced ahead of the first meeting. The main aim of the AI Council will be to provide strategic leadership and momentum in delivery.

The Office for AI will report to the AI Council regularly and will be subject to challenge sessions from government ministers on progress in implementing the Sector Deal. The Industrial Strategy team will provide the challenge on delivery timetable, metrics and ambition on outcomes as well as providing updates and escalation to ministers across the suite of Sector Deals.

References

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1. Hall, W and Pesenti, J - ‘Growing the Artificial Intelligence Industry in the UK’ (2017) - www.gov.uk/government/publications/growing-the-artificial-intelligence-industry-in-the-uk (https://www.gov.uk/government/publications/growing-the-artificial-intelligence-industry-in-the-uk) ↩
2. Industrial Strategy Challenge Fund challenges are subject to HM Treasury business case approval. ↩
3. This includes third party funding as well. ↩
4. Oxford Insights - ‘Government AI Readiness Ranking Index’ (2017) - www.oxfordinsights.com/government-ai-readiness-index/ (https://www.oxfordinsights.com/government-ai-readiness-index/) ↩
5. Industrial Strategy Challenge Fund challenges are subject to HM Treasury business case approval. ↩
6. PWC - ‘The Impact of Artificial Intelligence on the UK Economy’ (2017) - www.pwc.co.uk/economic-services/assets/ai-uk-report-v2.pdf (https://www.pwc.co.uk/economic-services/assets/ai-uk-report-v2.pdf) ↩

7. PR Newswire - ‘Artificial Intelligence Market Report’ (2016) - www.prnewswire.co.uk/news-releases/artificial-intelligence-marketreport-2016—global-forecastto-2022-artificial-intelligence-aimarket-is-expected-to-be-worthusd-1606-billion-by-2022-ata-cagr-of-629—research-andmarkets-606786556.html (http://www.prnewswire.co.uk/news-releases/artificial-intelligence-marketreport-2016---global-forecastto-2022-artificial-intelligence-aimarket-is-expected-to-be-worthusd-1606-billion-by-2022-ata-cagr-of-629---research-andmarkets-606786556.html) ↩
8. Hall, W and Pesenti, J - ‘Growing the Artificial Intelligence Industry in the UK’ (2017) - www.gov.uk/government/publications/growing-the-artificial-intelligence-industry-in-the-uk (https://www.gov.uk/government/publications/growing-the-artificial-intelligence-industry-in-the-uk) ↩
9. 80% of AI companies, according to Sonovate - 50 Hottest UK AI Companies (2017) - www.sonovate.com/quickview/50-hottest-uk-ai-companies (http://www.sonovate.com/quickview/50-hottest-uk-ai-companies) ↩