UK-Netherlands & Artificial Intelligence

Policies, trends and opportunities for bilateral collaboration

December
2021

Kingdom of the Netherlands

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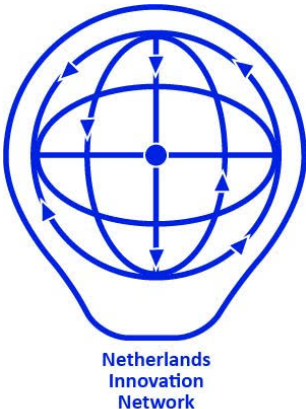
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Executive summary

The UK has a burgeoning artificial intelligence (AI) community across the country, with London being the number one city in Europe for AI, boasting strong investor networks and some of the best in class AI research universities and institutions. There are a number of cutting-edge advanced machine learning (ML) techniques that are being harnessed by universities and companies of all sizes, especially around federated learning (defined in the z) and explainable AI.

1,500+
UK AI startups and scaleups, with London ranking as Europe's AI capital[1]

3rd
UK's global ranking in terms of % of AI leaders[2] by nation

60%
of UK AI startups deemed at 'low risk' of closure due to COVID-19[3]

The UK government has demonstrated its commitment to the development and deployment of AI - and broader ambitions - through a number of existing and upcoming strategies, funding opportunities, policies, and dedicated teams within government departments. Major commitments include the recently published AI Strategy and the AI Sector Deal, as well as the work being advanced by the joint-departmental Office for AI, the Centre for Data Ethics and Innovation (CDEI), the Central Digital and Data Office (CDDO) and many more. The government and other government-funded bodies, such as Innovate UK, have supported a robust portfolio of AI projects, all of which have started to demonstrate their potential to hugely benefit the economy.

Large untapped benefits from AI and machine learning still exist. The pandemic has driven change in unprecedented ways in societies across the world. As a result, we have seen businesses moving to digitalise faster than ever in order to cope with the challenges and opportunities being experienced through remote working; health, safety and social distancing; changing consumer habits and shocks to supply chains. And all this is coinciding with increasing urgency to address the challenges of the climate emergency.

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1 Digital Future Index, Digital Catapult, 2021

2 'AI leaders' are defined as firms widely using AI to generate benefits in the research conducted by ESI Thought-Lab, available here (2020).

3 With the general startup landscape sitting at 33% according to Beauhurst, this is very promising for the AI ecosystem.

AI and other advanced digital technologies are the fundamental building blocks for future economic growth and competitiveness around the world, spanning transformational capabilities, especially in combination with immersive technologies such as: virtual and augmented reality (VR and AR); blockchain and distributed ledger technologies (DLT); advanced digital networks (5G); the internet of things (IoT); and - in the future - quantum computing. These technology families are important in their own right, but even more so when combined with complex cyber-physical systems.

The UK's corporate and startup community, coupled with a number of government-funded initiatives, places the UK in a unique position to harness the power of advanced digital technologies. The opportunity for AI to reform logistics and manufacturing operations and make them more resilient and sustainable, or to enable smarter cities, food systems and workplaces, is vast. Good AI design, development and deployment can be promoted through robust government policy and intervention to support both innovative startups and established industry sectors. There are also ample opportunities for bilateral collaboration on AI - connecting key priorities between two countries.

This report first addresses the trends within the AI ecosystem in the UK and abroad, before delving into the ways in which the UK government is supporting the AI and innovation ecosystem. It then provides an overview of some of the regulatory trends and how these can affect the AI ecosystem and innovation at large. The report then points to some opportunities that AI can bring for key sectors of the economy by providing specific case studies. It then outlines a number of barriers to adoption for both the supply and demand side of the AI ecosystem, which have been identified through primary and secondary research.

Finally, the report draws some parallels with the AI ecosystem in the Netherlands, and addresses a number of ways in which the Dutch government could best engage with the AI community in the UK. As the leading UK authority on advanced digital technologies, Digital Catapult recommends that the Dutch government engages in bilateral innovation and R&D activities with the UK to capitalise on and benefit from the UK's world-leading AI startup community and research centres. The Netherlands can best achieve this in the following four main ways:

General recommendations

Recommendation 1: Build closer relationships between the Netherlands and key UK government bodies to develop shared policy learnings on AI and innovation.

These key bodies should include: the Office for AI, UK Research and Innovation (UKRI), the AI Council, and the Centre for Data Ethics and Innovation (CDEI). These relationships should explore areas such as industry adoption of AI and innovation, startup and scaleup support, and standards development and ethics. A closer relationship with key policy players could be particularly useful given the Netherlands' shared commitment with the UK to the ethical use of AI in the public sector, and the UK government's mission to develop an AI technical standards engagement toolkit as part of the global AI standardisation landscape. The UK government will also be publishing a white paper in 2022 on a pro-innovation national position on governing and regulating AI, which could benefit from international lessons learned.

Recommendation 2: Launch bilateral funding mechanisms for AI innovation and R&D.

Bilateral funding mechanisms would build and strengthen direct avenues for collaboration and knowledge sharing between industry, innovators, academia and the wider innovation ecosystems in both countries. Such bilateral programmes and activities will create lasting trade and research relationships on key areas of common interest such as sustainability and ethics, and would achieve policy objectives in both countries. The UK's AI Strategy commits the UK government to work with global partners on shared R&D challenges, and to include trade deal provisions in emerging technologies including AI, while the Netherlands is strengthening bilateral knowledge exchange with like-minded countries on AI through various innovation missions.[4] Both countries are also part of the Global Partnership on Artificial Intelligence (GPAI).

Recommendation 3: Set up a UK-Netherlands AI industry innovation and adoption forum.

This annual forum would bring together representatives of the UK and Netherlands AI innovation ecosystem to set out a roadmap with recommendations updated on a yearly basis. The aim would be to stimulate adoption of AI in areas such as sustainability and net zero, healthcare, logistics and supply chains, smart cities, and advanced cyber physical infrastructure. Forum outcomes could feed into the UK government's forthcoming joint Office for AI-UKRI programme to stimulate the development and adoption of AI technologies in high potential, lower-AI-maturity sectors, as well as the forthcoming National Cyber-Physical Infrastructure Framework.

Recommendation 4: Explore, build and deliver AI demonstrators for industry and innovation players in both countries.

Leveraging the strengths of the UK's Catapult Network, and AI-related programmes from Digital Catapult, the creation of bilateral AI demonstrators would enable key Dutch and UK industrial players (who could act as challenge owners) to connect with relevant stakeholders in the UK and Netherlands innovation ecosystems in a meaningful way. These demonstrators would showcase carefully selected UK and Dutch innovative startups and enable them to attract investment and strengthen the startup community in both countries. This would encourage further bilateral activities, allowing the UK Catapult Network to work with startups, scaleups and industry from both countries on specific industry areas (energy, smart cities, healthcare and more)[5], solving UK-Netherlands industry challenges while demonstrating AI and other technology-enabled solutions. This would open up opportunities for both countries to attract FDI and demonstrate export strengths.

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4 As stated in the recent Dutch Digitalisation Strategy (2021), the government has increased bilateral knowledge exchange with countries including the United States and Singapore, and is working bilaterally with Belgium, Germany and France. As part of its bilateral work with Germany, the Netherlands has launched the German-Dutch 'virtual' field lab AI4DT where SMEs can test and apply AI in combination with 'digital twins'.

5 The UK's Catapult Network supports businesses in transforming ideas into valuable products and services. Established by Innovate UK, the network brings together nine world-leading technology and innovation centres in the following areas: Cell and Gene Therapy, Compound Semiconductor Applications, Connected Places, Energy Systems, High Value Manufacturing, Medicines Discovery, Offshore Renewable Energy, Satellite Applications, and Digital.

Introduction and big picture

The UK is consistently highly ranked globally in many aspects of AI. London continues to be a global epicentre for AI startups, and there are pockets of innovation all across the country, clustered with prestigious and world-leading universities with expertise in AI. This section explores the UK AI startup landscape and where the country ranks globally, as well as some of the emerging trends within the field of machine learning and how the UK is harnessing them.

The startup landscape

London's position as the leading European tech hub as measured by total capital invested was consolidated in 2021.[6] There are over 1,500 high-growth AI companies in the UK, with about 60% of these businesses located in London alone.[7] London continues to be the highest performing capital in Europe for AI startups specifically, while other top UK cities include Edinburgh, Glasgow, Cambridge, Manchester, Oxford and Leeds.[8] Even with the severe effects of the global pandemic, AI companies have proven to be relatively stable: in July 2020, 60% of UK AI startups were deemed at 'low risk of permanent closure' by Beauhurst. As the general startup ecosystem average was sitting at 33%, this is very promising for the UK AI landscape. In addition, almost 30% of UK AI startups have been deemed positively affected by the pandemic, with a reporting of a surge in demand for their services.[9] Only 3% of AI startups have been severely or critically affected by COVID-19 directly and by its subsequent measures.[10] Only 7% of startups have reported loss of key customer groups: typically startups whose main clients are within the hospitality, events, or aviation sectors. The stability of these startups might also be attributed to their intersection with a multitude of key or essential sectors, such as healthcare, transportation, manufacturing, and more.

Where the UK ranks globally

The estimates of what AI will add to the global economy are huge. According to research conducted by ESI Thoughtlab, Deloitte and others in 2020, the UK ranked third in the world for its proportion of 'AI leaders', defined as companies 'widely using AI to generate benefits'[11] - just behind Japan and the USA, and ahead of China and other countries in Europe. The UK also ranks third out of 62 countries (after the US and China) on Tortoise Media's Global AI Index, which benchmarks nations on their level of investment, innovation and implementation of artificial intelligence. The Global AI Index is underpinned by 143 indicators split across seven sub-pillars: Talent, Infrastructure, Operating Environment, Research, Development, Government Strategy and Commercial. According to the Global AI Index, the UK ranks third globally for AI 'research', which focuses on the extent of specialist research and researchers by investigating the number of publications and citations in credible academic journals. According to the UK's National AI Strategy, in terms of AI startups and scaleups, private capital invested and conference papers submitted, the UK sits in the top tier of AI nations globally. The UK ranked third in the world for private investment into AI companies in 2020, behind only the USA and China.[12] Finally, in Digital Catapult's Digital Future Index, the total funding for the UK advanced digital technologies market is an estimated £10.4 billion, with AI companies receiving nearly £2.5 billion. The UK is home to over 7% of AI companies globally, with the majority of these companies focusing on information technology (34.8%), followed by financial services (12.7%), professional services (11.9%) and healthcare (9.7%), as identified in the Digital Future Index.

6 State of European Tech, Atomico, 2021
7 The Top 50 AI Companies in the UK, Beauhurst, 2021
8 UK Startup Explorer, Sifted, 2021
9 Analysing the impact of COVID-19 on UK AI startups, Beauhurst, 2020
10 Analysing the impact of COVID-19 on UK AI startups, Beauhurst, 2020

11 Driving ROI Through AI, ESI Thoughtlab, Deloitte, Cognizant, et al., 2020
12 UK National AI Strategy, 2021

Despite these strong foundations for AI in the UK, industry AI adoption has a more varied picture. Whilst the AI research capabilities in the UK are world leading, there is a challenge in converting this excellence into a commercial edge. Currently, AI research undertaken in the UK is world class, and investments in AI R&D contribute to the government's target of increasing overall public and private sector R&D expenditure to 2.4% of GDP by 2027. But generating economic and societal impact through adoption and diffusion of AI technologies is behind where it could be.[13] The government recognises that there is an opportunity to build on existing strengths in AI research and ensure that they translate into productive processes throughout the economy.[14]

Emerging trends within machine learning and AI

Within the machine learning space, a number of trends are emerging. Combining ML with a number of other technologies, including virtual reality, the IoT and blockchain, is contributing to developing cyber-physical infrastructures. A large number of startups are using IoT sensor data to feed into their AI models, creating a generation of relevant and rich datasets, constantly updated with real-time feedback loops, for a host of AI use cases. Further, AI coupled with blockchain is emerging within supply chain management for provenance and tracking the flow of goods - all exemplified throughout the report.

There are also a number of machine learning methods and ML subsets that are gaining traction, including computer vision, federated learning and transfer learning. 2020 was the year that federated learning saw its first commercial application outside of Google, Apple, Amazon, Microsoft and Facebook.[15] For example, French-American scaleup Owkin uses federated learning to accelerate drug discovery, while Shoji, headquartered in London, allows businesses to license the

use of their data without needing to share the data itself. Their federated learning platform keeps data in its original location, offering data owners control over who can use their data and how. There is a growing interest in federated learning from an R&D perspective as well, with government-funded projects that focus on developing this advanced type of machine learning, such as KnowRisk, detailed on page 25 of the report.

What is federated learning?

The term federated learning was first introduced in 2017, and unlike traditional or standard machine learning approaches - which are predicated on centralising training data on one machine or data centre[16] - federated learning allows collaborative machine learning without centralised training data. This effectively enables the building of machine learning models with richer and increased voluments of richer data without having to exchange private data between parties.[17] This is significant because a large barrier to developing good AI is often access to data and the reluctance of parties to share data with each other. Federated learning can therefore be applied as a technical solution to a cultural problem.[18]

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16 Federated Learning: Collaborative Machine Learning without Centralized Training Data, Google AI Blog, 2017
17 What is Federated Learning?, Open Data Science (ODSC), 2020
18 It is also the case that regulation may not allow sharing of data between parties within some sectors (such as medicine and healthcare), making federated learning an important technique to accelerate medical research.

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13 Global Innovation Index 2020 Report, 2020
14 UK National AI Strategy, 2021
15 State of AI Report 2021, Nathan Benaich and Ian Hogarth, 2021

The UK is also pioneering technical approaches to explainability within AI algorithms, and to overcoming the opacity of the so-called 'black box'.
Different use cases are being developed in UK universities to promote algorithm transparency, especially given the UK's focus and expertise on AI ethics and responsible innovation.[19] For example, Imperial College London researchers have helped organise the Explainable Machine Learning Challenge - a competition run jointly by organisations including Google, data analytics company FICO and several universities - that challenges researchers to create ML algorithms that are both accurate and explainable.[20]

UK government policy and strategies for AI

The UK government demonstrates its commitment to the development and deployment of AI, as well as broader digital ambitions, through a number of existing and upcoming strategies, policies, partnerships, and dedicated teams within government departments. This section explores some of these major commitments in recent years, as well as some regulatory developments that will have implications for the UK's AI landscape.

The UK's National AI Strategy

In September 2021, the UK government published its long-anticipated National AI Strategy. This built on a number of other initiatives and strategies that are described below. The National AI

The UK's National AI Strategy

The National AI Strategy is intended to make the UK a 'global AI superpower' over the next 10 years. Three fundamental pillars underpin the strategy:

1. Investing and planning for the needs of the UK's AI ecosystem
2. Ensuring AI benefits all sectors and regions of the UK
3. Developing a pro-innovation regulatory and governance framework for AI

The main goals of the strategy are for the UK to:

- Experience growth in numbers and types of AI discoveries to be commercialised and exploited in the UK
- Benefit from the highest amount of AI-enabled economic and productivity growth
- Establish the most trusted and pro-innovation system for AI governance in the world

The strategy indicates that the main drivers of progress in AI are access to people, data, compute power and finance.

The document includes a series of concrete actions that the government intends to take over the short and long term to realise its strategy. A few actions that will particularly impact AI development and deployment in the short to medium term include:

- Publishing a white paper on a pro-innovation position on how to govern and regulate AI
- Determining the role of data protection in wider AI governance
- Evaluating the private funding needs and challenges of AI scaleups
- Building an open repository of AI challenges with re-

al-world applications
- Publishing research into the opportunities to encourage diffusion of AI across the economy
- Piloting an AI Standards Hub to coordinate UK engagement in AI standardisation globally
- Establishing medium and long term horizon scanning functions to increase government's awareness of AI safety
- Rolling out new visa regimes to attract the world's best AI talent to the UK

In the longer term, the UK aims to take a much more global approach to develop its AI ecosystem, and some actions include:

- Launching a joint Office for AI and UKRI programme to stimulate the development and adoption of AI technologies in high potential, lower AI maturity sectors
- Working with global partners on shared R&D challenges
- Including trade deal provisions in emerging technologies (such as AI)
- Developing an AI technical standards engagement toolkit to support the global AI standardisation landscape
- Launching a new National AI Research and Innovation Programme that will align funding programmes across UKRI and support the wider ecosystem

The Office for AI is responsible for the overall delivery of the National AI Strategy, monitoring progress and enabling its implementation across government, industry, academia and civil society. Some actions have already been taken, such as the recent launch of a consultation on copyright and patents for AI, or the publication of an AI assurance roadmap (detailed on page 19).

Background to the National AI Strategy

Approving a formal AI strategy was one of the recommendations by the House of Lords Liaison Committee in its No Room for government complacency on artificial intelligence report (December 2020). The Lords Liaison Committee report - which examined progress in the implementation of recommendations made in a previous report by the Lords Select Committee on AI in 2018 - had called for:

- A Cabinet Committee to commission and approve a five-year strategy for AI
- Improvement of access to the internet and enhancement of the UK's digital skills
- Identification of job types that are at most risk of AI automation, and creation of national training schemes to support people to retrain into other careers
- Having the Centre for Data Ethics & Innovation (CDEI) create and publish national standards for the ethical development and deployment of AI

The Centre for Data Ethics & Innovation

The Centre for Data Ethics and Innovation (CDEI) was set up in 2018 as part of the Department for Digital, Culture, Media & Sport (DCMS). This independent advisory body is tasked by the government to connect policymakers, industry, civil society, and the public to develop the governance regime for AI and data-driven technologies. It shapes recommendations for the government, as well as advice for regulators and industry to support responsible innovation. In recent months, the CDEI published research on the use of AI and data-driven technology in the UK's COVID-19 response, an independent report into the role of data intermediaries, and a roadmap setting out the steps required to build an AI assurance ecosystem (detailed on page 21).

In January 2021, the AI Council - an independent expert committee that provides advice to the government and high-level leadership of the AI ecosystem - published the AI Roadmap, which included recommendations to help the UK government's strategic direction on AI (and which echoed those made by the House of Lords Committees). In February 2021, the government published a formal response to the Lords Select Committee on Artificial Intelligence 2018 report, in which it committed to 'delivering on the power and promise of AI, including working with the AI Council to embed the recommendations of their AI Roadmap'.

In March 2021, the Department for Digital, Culture, Media and Sport (DCMS) published its Ten Tech Priorities, which set the scene for the current National AI Strategy. These priorities included: growth of the economy through widespread use of AI technologies; ethical, safe and trustworthy development of responsible AI; and resilience in the face of change through an emphasis on skills, talent and R&D.

AI and data Grand Challenge

The direction of the UK policy landscape around AI was first launched in 2017, when the government set out its Industrial Strategy. The Industrial Strategy, which has now been revamped by Build Back Better: our plan for growth, set out the government's AI and data Grand Challenge. This paved the way for the publication of the AI National Strategy in September 2021. The AI and data Grand Challenge was one of the four Grand Challenges identified in the Industrial Strategy, along with: an ageing society; clean growth; and the future of mobility. The government also set up the Industrial Strategy Challenge Fund (ISCF) to take on the Grand Challenges and strengthen UK science and business innovation. The ISCF continues to provide funding opportunities today.

The 2021 plan for growth and the 2017 Industrial Strategy

"The 2017 Industrial Strategy set out a cross-economy approach to boost productivity. But much has changed since 2017, so it is right that we create a new framework for how we will build back better. This document details our focus on infrastructure, skills and innovation. It reflects new opportunities available to us following our exit from the European Union, opening up new ways to drive growth and supporting our vision for Global Britain."

HM Treasury, Build Back Better: our plan for growth, March 2021
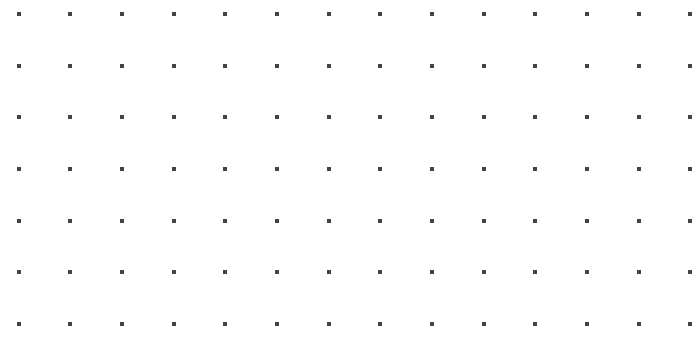
In 2017, the Government set up the Office for Artificial Intelligence, a joint departmental unit responsible for implementing the National AI Strategy, as well as overseeing the implementation of the AI and data Grand Challenge. The mission of the Office for AI is to drive responsible and innovative uptake of AI technologies by 'engaging organisations, fostering growth and delivering recommendations around data, skills and public and private sector adoption'.

The AI Sector Deal

In April 2018, the government announced its AI Sector Deal to boost the UK as a leader in developing AI technologies, and to support the achievement of its AI and data Grand Challenge. The AI Sector Deal represented the first major commitment from government and industry to realise this technology's potential, with a package of close to £1 billion of overall support for the sector (of which over £600 million was newly-allocated funding, and up to £342 million came from existing budgets), alongside £250 million for Connected and Autonomous Mobility (CAM) technology through the Centre for Connected and Autonomous Vehicles (CCAV, detailed on page 22).

The AI Sector Deal aimed to attract and retain AI talent; deliver upgrades to the UK's digital and data infrastructure; and ensure that the UK is the best place to start and grow an AI business. It is one of the ten sector deals, or partnerships between government and industry on sector-specific issues. It also drew on the government's Digital Strategy, which was first announced in 2017 to reinforce the UK's strengths in telecoms, data and enterprise, and which is expected to be updated in response to the pandemic in 2022.[21]

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21 In the National AI Strategy published in September 2021, the government indicated that the forthcoming Digital Strategy will build on the DCMS Ten Tech Priorities.

The AI Sector Deal was published following the recommendations of the 2017 independent AI review [Growing the AI industry in the UK](#), led by Professor Dame Wendy Hall and Jérôme Pesenti. Their review identified ways to boost the UK's emerging AI sector both nationally and internationally, as well as recommendations to improve the institutions that support AI, build a skilled workforce, and stimulate access to data.

Other initiatives with implications for AI in the UK

There are a number of ongoing strategies that place technological advances and innovation at the centre of the UK's recovery from COVID-19. In December 2020, the UK government announced its [National Data Strategy](#) (NDS) to help organisations across the public, private and third sectors to make better use of data. This strategy builds upon initiatives such as the Industrial Strategy, the AI review (led by Professor Dame Wendy Hall and Jérôme Pesenti), the AI Sector Deal, and the [UK Research and Development Roadmap](#) (which outlines the UK's vision and ambition for science, research and innovation). The NDS sets out a framework for how to approach and invest in data. It has four main pillars: data foundations, data skills, data availability, and responsible data. Based on these four areas of interest, the strategy proposes five priority missions:

1. Unlocking the value of data across the economy
2. Securing a pro-growth and trusted data regime
3. Transforming government's use of data to drive efficiency and improve public services
4. Ensuring the security and resilience of the infrastructure on which data relies
5. Championing the international flow of data

The NDS recognises that AI is increasingly being used to enhance our digital and physical experiences: data can 'support the delivery of existing services, from manufacturing to logistics', which are needed for the delivery of public services and societal goals such as tackling climate change and supporting

the National Health Service. Through the NDS, which is now in its implementation phase after a period of public consultation that ended in December 2020, the UK government aims to set out a pro-growth data environment for the UK to be the leading data economy, while ensuring public trust in data use. The government's [response](#) to the consultation, published in May 2021, sets out in detail how it will achieve this ambition. As well as publishing its response, the government also launched a [National Data Strategy Forum](#) to help deliver the UK's National Data Strategy. In November 2021, the Government published a [framework](#) to make private and third sector data more usable, accessible and available across the UK economy while protecting people's data rights and private enterprise' intellectual property, in line with Mission 1 of the National Data Strategy.

Sustainability and AI - existing strategies

One of the AI Roadmap recommendations included the use of AI to 'meet the challenges of net zero carbon emissions'. In October 2021, the UK Government published its long-awaited [Net Zero Strategy: Build Back Greener](#) which includes a number of technology-driven approaches to reach the net zero goal. The strategy cites the example of agriculture and the [Farming Innovation Programme](#), which aims to drive development of new precision technologies, explore the potential of AI and robotics, and take advantage of new technologies such as gene editing.

In November 2021, a team of data experts was set up as part of a [scoping project](#) to help the UK's research and innovation sector reach net zero. The proposals will ensure that all the digital tools used throughout the sector - from supercomputers to phones - will be carbon neutral by 2040. The team will be analysing the entirety of UK Research and Innovation's (UKRI) digital estate. The £1.9 million project is funded by the [Natural Environment Research Council](#).

To support the Net Zero Strategy, the government launched the [Flexibility Innovation Programme](#) which seeks to enable large-scale widespread electricity system flexibility through new technologies. Up to £65 million will be made available to fund innovation across a range of applications, and the programme's anticipated areas of focus include data and digitalisation solutions for increased flexibility. This programme is part of the government's £1 billion [Net Zero Innovation Portfolio](#) which focuses on ten priority areas identified in the Ten Point Plan

for a Green Industrial Revolution from November 2020. The government published its Ten Point Plan during COVID-19, and point 10 referred to the need to accelerate the commercialisation of low-carbon technologies, systems and processes in the construction and industrial sectors. The Ten Point Plan built on the 2017 Made Smarter Review, which set out a vision for growth and increased productivity across the manufacturing sector through Industrial Digital Technologies (IDTs).

Prior to publishing its Net Zero Strategy, the Department for Digital Culture Media and Sport launched the Tech Zero Taskforce, a group of tech companies committed to climate action. In July 2021, the UK government published its Smart Systems and Flexibility Plan 2021 and Energy Digitalisation Strategy, which identified key policy priorities to enable the transition to a smart, flexible and decarbonised energy system.

The government published a series of other strategies and proposals related to net zero, such as the Industrial Decarbonisation Strategy published in March 2021 which echoed the need for disruptive technologies such as AI for decarbonisation, or the Energy white paper: Powering our net zero future, highlighting the potential of AI and data-driven approaches in the context of, for instance, battery optimisation for owners of battery storage and other flexible energy assets. The government also committed resources to innovation for sustainability in its Spending Review 2020, such as the £81 million of R&D funding made available for low and zero emission transport technologies.

The Alan Turing Institute

Founded in 2015, The Alan Turing Institute is the UK's national institute for data science and artificial intelligence. It has a unique structure, working with 13 universities and the UK Engineering and Physical Science Research Council (EPSRC). It was founded by EPSRC and five universities – Cambridge, Edinburgh, Oxford, UCL and Warwick - with eight new universities – Leeds, Manchester, Newcastle, Queen Mary University of London, Birmingham, Exeter, Bristol, and Southampton – joining in 2018.

The Institute has ambitious focuses spanning urban analytics and city wide infrastructure, and using machine learning to simulate cities. One particular project looks at using data wrangling to bring together social and smart city data sets, looking at emergent patterns and processes within geographical and social systems from these new data sets in order to build better city applications.

Transport & AI - existing strategies

The government published its Transport decarbonisation plan in July 2021 on the back of the Decarbonising transport: setting the challenge, published in March 2020, which had laid out the scale of reductions needed to reach the legally binding carbon targets and deliver net zero by 2050. The new plan sets out measures and recommendations to optimise logistics efficiency, explore innovative digitally-enabled solutions and increase data sharing. The government also commits to seize the opportunities driven by advances in data science and AI to transform

the way people, goods and services move. Priority 5 of the plan is to make the UK a hub for green transport, technology and innovation.

In September 2019, the Department for Transport published its ambitions for the future of the British maritime sector with its Maritime 2050: navigating the future plan. The government acknowledged that among the key trends influencing the direction of the maritime sector, disruptive technologies (including AI,

blockchain and digitisation) will stand out. Specifically, smart vision to have the most effective border in the world. As part of the strategy, the government has committed £180 million for its Single Trade Window, which aims to reduce the cost of trade by streamlining trader interactions with border agencies. This will require the use of data to explore international interoperability and increased supply chain visibility.

In March 2019, the government published its Future of Mobility: urban strategy as part of its Future of Transport programme to put the UK at the forefront of mobility innovation. This strategy was a key step for the Industrial Strategy's future of mobility Grand Challenge. The Future of Mobility strategy acknowledged the potential of machine learning for transport, including enabling self-driving vehicles, identifying congested areas, and more accurately predicting public transport times. By fostering an enabling environment for new transport technologies and building on existing strengths such as zero emission vehicles and AI, the UK can attract inward investment and generate high-value jobs.

Defence & AI - existing and upcoming strategies

The Ministry of Defence (MOD) is currently preparing to publish a new Defence AI Strategy aimed at accelerating the research, development, testing, integration and deployment of AI to be used in information, logistics, ISTAR or other 'non-weapon' systems. This programme of work is part of the government's Innovation Strategy, published in summer 2021. The government will also support new opportunities to strengthen the innovation ecosystem through public procurement reforms, committing £800 million to the new Advanced Research and Invention Agency (ARIA), a body whose functions will be based on those of the US Advanced Research Projects Agency (ARPA) now renamed DARPA (Defense Advanced Research Projects Agency).

Relatedly, the March 2021 Integrated Review of Security, Defence, Development and Foreign Policy covered global opportunities for the UK post-Brexit, setting out a vision of the UK's place in the world that will permeate other government strategies. The UK wants to position itself as a global leader in research around climate change and biodiversity, science and technology, and healthcare. Artificial intelligence, along with cyber security, quantum, and digital twins, are all mentioned as key strategic technologies for the UK. As part of the Prime Minister's vision for the UK in 2030, the government aims to continue being recognised as a global leader in science and technology, with an established leading edge in areas including AI. This means that the UK will continue to be one of the best places to start and build technology and tech-enabled businesses.

Other commitments to science and innovation

In July 2021, the UK published its Innovation Strategy, which commits to putting the UK at the front of the "global innovation race", as described by Business Secretary Kwasi Kwarteng. The Innovation Strategy is a long-term plan to boost private sector investment into innovation and create enabling conditions for businesses to turn science and R&D into new products and services. The strategy puts innovation at the heart of 'building back better from the pandemic' and of the government's Build Back Better plan for growth, announced in March 2021. The strategy identified seven strategic technology families where the UK has R&D and industrial strength, which include 'AI, Digital and Advanced Computing'. The government will specify 'Innovation Missions' determined by the National Science and Technology Council (which views artificial intelligence as a core priority) and the Office for Science and Technology Strategy, both set up in June 2021. Innovate UK and UK Research and Innovation will operationalise this strategy, while universities and other research organisations, charities, Catapults, and public sector research establishments will play a key role in its implementation, along with the upcoming Business Innovation Forum.

In November 2021, Innovate UK, the UK government's innovation agency, announced its Plan for Action for Business Innovation setting up how the government intends to deliver on the Innovation Strategy over the next four years. The Plan for Action aims to serve and support UK businesses to use innovation to drive economic recovery; fulfil net zero obligations; help keep everybody in the UK healthy and safe; and educate young people and develop the innovators of the future. Innovate UK will issue a delivery plan with detailed actions each year.

In October 2021, the Chancellor of the Exchequer delivered the government's autumn Budget and Spending Review 2021 (SR21) which outlined the financial plan for the upcoming year. The announcement included some specific commitments to innovation: the core science funding will be upped by £1.1 billion, the budget for Innovate UK will be increased to a total of £2.5 billion (a 36% increase) over the SR21 period, £1.7 billion would be devoted to Net Zero R&D, and the £800 million for the Advanced Research and Invention Agency (ARIA) were reiterated. The UK government committed to fully funding Horizon Europe (£5.9 billion), the EU's key funding programme for research and innovation. Public R&D investment will increase to £20 billion by 2024-25, contributing to the government's ambition to increase R&D spending to £22 billion by 2026-27, and drive economy-wide R&D investment to 2.4% of GDP in 2027. This will also support the priorities agreed by the Prime Minister's new National Science and Technology Council, such as quantum computing, artificial intelligence, bioinformatics and space technologies.

Combined with the R&D tax reliefs announced in the previous budget, which are now going to be modernised and refocused by expanding the scope of eligible expenditure to include data sets and cloud computing costs, total UK government R&D support as a proportion of GDP is forecast to increase to 1.1% in 2024-25, from 0.7% in 2018. This builds on the commitments made in the March 2021 Budget, which was generally well received[22] by the UK tech community as it included a number of innovation-focussed measures (such as a new share options scheme and pension fund rules to allow further investment in venture capital, or the £375 million UK-wide Future Fund: Breakthrough to encourage private investors to co-invest with the government in high-growth, innovative firms).

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22 A number of comments by tech executives and trade bodies were made to the press following the Chancellor's announcement of the Budget. Some examples can be found in an article published by City A.M.'s James Warrington here (3 March 2021).

Regulation and AI

The UK's exit from the EU presents opportunities to autonomously redesign national regulation. In February 2021, the government set up the Taskforce on Innovation, Growth and Regulatory Reform (TIGRR) to ensure that this new set of opportunities is taken advantage of. In June 2021, the Taskforce published a report for the government with steps and proposals to stimulate business dynamism and innovation, ensure open and competitive markets, and support businesses. The Taskforce considered:

1. Opportunities to drive innovation and accelerate the commercialisation and safe adoption of new technologies
2. Opportunities to reduce barriers to entry in specific markets and make markets more dynamic
3. Opportunities to reduce administrative barriers for scale-ups and to tailor processes to the needs of UK startups and SMEs
4. Opportunities to improve small business' experience of regulatory requirements
5. Sectors of the economy or regulatory frameworks to prioritise for further regulatory analysis

The report recognises that AI has a key role to play in innovation, both in the UK and globally over the coming years. The Taskforce also recognised that the UK has the 'opportunity to cement its position as a world leader in data, through a combination of proportionate, targeted reforms that boost innovation'.

In August 2021, the government published a package of measures aiming to 'seize the opportunities of data to boost growth, trade and improve public services' through a reform of the ICO, as well as the launch of a public consultation on the proposed changes to the data protection regime, which closed in November 2021. The government began setting up the International Data Transfers Expert Council, a subgroup of the National Data Strategy Forum, bringing together 15 experts whose aim is to provide independent advice to help deliver the government's mission to champion the international flow of data and forge strategic data partnerships with key economies worldwide. The government's focus on its data regime was spurred after the EU adopted a data 'adequacy' decision, formally recognising the UK's data protection standards, thus continuing the flow of personal data from the EU to the UK.

In July 2021, the UK government published its overall Plan for Digital Regulation, which sets out its approach for governing digital technologies to drive growth and innovation. The plan includes new principles to guide the design and implementation of regulations concerning digital technologies, as well as some practical proposals to ensure a coherent regulatory landscape. Also in July 2021, the government's Regulatory Horizons Council - an expert committee that aims to identify the implications of technological innovation and advises the government on regulatory reform - published a report on the future of technological innovations and how regulation can act as an enabler. With respect to AI, the Council suggested that the risks and levels of concern vary according to the technology's application. This is highlighted as a challenge for regulation since applications may vary significantly across areas. Applications where regulation might stifle AI innovation include optimisation of systems such as logistics networks and energy product ion (supporting net zero), drug discovery, and diagnosis. As the government is expected to publish a white paper on regulation and governance for AI in 2022, all these considerations are expected to shape and influence a potential future regulatory framework for AI in the UK.

Online harms and competition

The UK has been leading the way in terms of regulating online content and digital markets. With its Online Safety Bill overseen by communications regulator Ofcom, and its pro-competition regime for digital markets led by the Competition and Markets Authority (CMA) respectively, the UK is helping to set the standard for safer online experiences and competitive digital markets. The UK's leading stance on technology regulation has the potential to make the internet safer for society, and level the playing field for smaller, innovative startups.

The Online Safety Bill

In December 2020, the UK government unveiled its full response to the Online Harms White Paper consultation, setting out the framework and direction of its Online Safety Bill to regulate online content. The draft legislation was published in April 2021, and the Joint Committee on the Draft Online Safety Bill published their report on the bill with recommendations for the government in December 2021. In its current form, the draft bill recognises the critical role of AI technology in improving user safety online - AI-based tools are being increasingly used to identify harmful content - which was also identified in the government's National Data Strategy and in the CDEI's AI Barometer. The CDEI's AI Barometer is an analysis of the most pressing opportunities, risks and governance challenges associated with AI and data use across five UK sectors. The analysis identified that AI systems have the potential to address online harms by, for example, limiting the spread of misinformation or identifying vulnerable users.

More recently, the CDEI also published a report on the role of AI in addressing misinformation on social media platforms, which details the findings from an expert forum with representatives from platforms, fact-checking organisations, media groups and academia. They conclude that algorithms enable content to be moderated at a speed and scale that would not be possible for human moderators. However, this needs to be carefully balanced with people's rights to free speech and autonomy, as well as with the risks associated with content being incorrectly identified as harmful. To improve the efficacy of moderation tools, the CDEI is currently working with the department for Digital, Culture, Media and Sport (DCMS) on the Online Safety Data Initiative (OSDI), launched in June 2021, to test methodologies enabling access to high quality datasets that can be used for training AI systems to better identify and remove harmful and illegal online content.

Spotlight: AI startup tackling harmful content online

Raven Science, based in London, created Raven, an intelligent software using machine learning to find, analyse and classify videos with illicit content. It combines advanced machine learning, image and object recognition, and crawling. Raven has been developed in partnership with extremism experts and trained using thousands of videos. Social media companies and online video content depositories can use Raven to identify content that violates their terms of service. It enables them to go rapidly through large quantities of content, helping human analysts in making the final decision regarding any given video or image. Raven Science was a member of Digital Catapult's Machine Intelligence Garage (MI Garage) April 2020 cohort.

The CDEI commissioned a report on algorithmic transparency in the public sector, published in June 2021. This follows on from the CDEI's 2020 review into bias in algorithmic decision-making, which recommended that the government should place a mandatory transparency obligation on all public sector organisations using algorithms when making significant decisions affecting individuals. To move this recommendation forward, the CDEI supported the Central Digital and Data Office (CDDO) in its development of a standard for algorithmic transparency, published in late November 2021. The standard will be piloted by several public sector organisations and further developed, based on feedback.

Spotlight: CDDO's Algorithmic Transparency Standard

Ofcom has recognised that it will need more expertise in the use of AI and how it is driving commercial and consumer change. The government echoed that these skills will be needed by all regulators overseeing activities and sectors with a digital dimension. The Algorithmic Transparency Standard helps public sector organisations provide information about the algorithmic tools they use, and why they are being used. The standard is made up of an algorithmic transparency data standard and an algorithmic transparency template and guidance that helps public sector organisations provide information to the data standard.

The Algorithmic Transparency Standard is part of the government's National Data Strategy. The strategy has a commitment to explore an appropriate and effective way to deliver greater transparency on algorithm-assisted decision making in the public sector. The National AI Strategy reiterated this commitment, with an action to conduct research that will help develop a cross-government standard for algorithmic transparency. CDDO developed the standard with civil society groups and external experts. The Cabinet Office established the Central Digital and Data Office - the new strategic centre for digital, data and technology (DDaT) for the government - in early February 2021.

In November 2021, the Digital Nations Ministerial Summit, which took place under the chairmanship of Chris Philp MP, Minister for Tech and the Digital Economy, welcomed initiatives advanced by the the Digital Nations Working Group on AI, including the 2021 paper Creating the Right Culture to Foster AI and Manage Change: Lessons from the Digital Nations. The Digital Nations ministers affirmed the importance of fostering responsible AI development and use in the public sector, and recognised the need to ensure public trust by considering factors such as AI bias, algorithmic transparency, ethical and other safeguards, and data management.

The CDEI aims to support private sector organisations in their use of AI as well. The Centre has published a roadmap setting out the steps required to bring coherence to the fragmented and nascent AI assurance ecosystem, and identifying the roles and responsibilities of different stakeholders. AI assurance services - including audit, certification and impact assessments - help verify that AI systems are effective, trustworthy and compliant with regulation, improving organisations' confidence to invest and delivering better outcomes for consumers. AI assurance will be critical to realising key actions included in the National AI Strategy, which aims to establish a trusted and pro-innovation system for AI governance. Assurance services for AI are currently relatively undeveloped; the roadmap sets out six priority areas for action:

1. Generate demand for assurance across the AI supply chain, improving understanding of risks and accountabilities for mitigating them
2. Build a dynamic, competitive AI assurance market, that provides services and tools
3. Develop standards that provide a common language for AI assurance
4. Build an accountable AI assurance profession to ensure that AI assurance services are also trustworthy and high quality
5. Support organisations to meet regulatory obligations by setting requirements that can be assured against
6. Improve links between industry and independent researchers, so that researchers can help develop assurance techniques and identify AI risks

Finally, as recognised in the National Data Strategy, initiatives such as Project ExplAIn, a collaboration between the Information Commissioner's Office (ICO) - the UK data protection authority - and The Alan Turing Institute - described on page 14 - aim to provide guidance for organisations to better explain decisions made using AI technology. Similarly, the ICO has also recently published an AI Auditing Framework focusing on best practices for data protection compliance by organisations.

Competition in digital markets

In July 2021, the Government unveiled its proposals to increase competition in the UK digital economy by announcing its new regulatory regime for digital markets. The Digital Markets Unit (DMU), set up in April 2021, as stated in the CMA's Digital Markets Strategy, will operationalise the 'pro-competition regime for digital markets' which specifically targets the most powerful tech firms: promoting greater competition and protecting consumers and other businesses from unfair practices.

 The CMA designed the unit in collaboration with the government, Ofcom and the ICO through the Digital Regulation Cooperation Forum (DRCF), whose new CEO, Gill Whitehead, was appointed in November 2021, and which recently launched a technology horizon scanning programme to provide a coherent view of new and emerging digital markets and technologies. The public consultation on the new pro-competition framework for digital markets, granting new powers to the DMU, ran from July to October 2021. The government is expected to issue a response to the consultation outcomes. In the meantime, the DMU has been established on a non-statutory basis. The DMU is expected to be given the power to designate tech firms that hold substantial and entrenched market power with Strategic Market Status (SMS), requiring them to follow new rules of acceptable behaviour with competitors and customers, to ultimately drive growth and innovation. Separately, the CMA's Data, Technology and Analytics (DaTA) unit has also launched the Analysing algorithms programme to identify how algorithms can reduce competition in digital markets and harm consumers, which will prompt further research into the responsible use of AI.

The European and global contexts

These two regulatory initiatives targeting harmful online content and digital markets - which are also being advanced by the European Union through the Digital Markets Act (DMA) and the Digital Services Act (DSA) respectively - could steer the UK innovation ecosystem in a safer and more competitive direction. The UK's Online Safety framework also includes support for media literacy and innovation across the growing safety tech sector - often AI-enabled - while the pro-competition regime

aims to foster 'dynamic and competitive digital markets that deliver for all in UK society'.

As stated in the UK government's Integrated Review of Security, Defence, Development and Foreign Policy, the UK will use its leadership in digital trade to 'advance WTO negotiations on e-commerce' and 'incorporate modern digital and data trade provisions in [its] Free Trade Agreements'. For instance, during the digital and tech ministerial meeting that took place ahead of the June 2021 G7 Leaders Summit, participants reached consensus that a more joined-up approach to regulation and promoting competition in digital markets is needed to better serve consumers and businesses. The G7 Digital and Technology Ministers' Declaration identified six priority interventions.[23] including a compendium of approaches to tackling competition issues in digital markets, to help ensure a collective recovery from COVID-19 with digital technology at its heart. To support these efforts, the UK hosted the Future Tech Forum on 29-30 November 2021 in London. The Forum was chaired by UK Digital Secretary Nadine Dorries and convened governments, industry, civil society and academia to discuss the opportunities that digital technologies can offer towards tackling global challenges across climate, health, building public trust in data, the future of the Internet, and digital governance.

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23 These interventions include:
1. Security, reliability and resilience in telecommunications infrastructure, including 5G and future networks
2. The Digital Technical Standards Points of Contact Group to support the development of digital technical standards
3. The 'G7 Roadmap for Cooperation on Data Free Flow with Trust' (DFFT)
4. The Safety Tech Summit, building on the 2021 G7 Internet Safety Principles
5. The compendium of approaches to tackling competition issues in digital markets
6. Collaboration for greater adoption of electronic transferable records

The UK AI ecosystem & government funding

This section will look to build a picture of the broader landscape of AI within the UK, focusing on where government investment into AI has focused - deep diving into government funded research centres and research projects. This section will focus on projects that are most relevant to smart cities and transport, and logistics and supply chains. It will also provide an overview of the most relevant research and experts centres in the UK.

Relevant government funded bodies and activities

Innovate UK is the UK's innovation agency. It is part of UK Research and Innovation (UKRI), a non-departmental public body funded by the UK government. Innovate UK's aim is to drive productivity and economic growth by supporting businesses to develop and realise the potential of new ideas. Innovate UK's strong business focus helps to drive growth by working with companies to de-risk, enable and support innovation. Innovate UK also funds business and research collaborations to accelerate innovation and drive business investment into R&D. Its funding support is available to businesses across all economic sectors, value chains and UK regions.
In the past, Innovate UK has awarded funding to a variety of projects. For example, Innovate UK and UKRI's Industrial Strategy Challenge Fund (ISCF) addresses 23 societal challenges faced by UK businesses, covering the four themes of the government's 2017 Industrial Strategy, which included artificial intelligence and data. The fund is backed by £2.6 billion of public money, and £3 billion in matched funding from the private sector.

The funding competition, Made Smarter Innovation: Sustainable Smart Factory, is aimed at UK-registered businesses and organisations, which could receive a share of up to £20 million for digital innovation projects that improve resource and energy efficiency of manufacturing processes in factories. To be eligible, projects must be data-centric (and can involve significant use of data sets). Industrial digital technologies (IDTs) can AI and ML. The funding call from November 2020 was aimed at

UK businesses using robotics and AI technologies that focus on areas including logistics; warehousing and transportation; agriculture and food production; construction; general-purpose remote working robotics; and robotics contributing towards the net zero commitment.

Innovate UK is also involved in the activities associated with Enterprise Europe Network, which offers small to medium sized businesses local access to information on doing business, finding collaborative partners, and increasing competitiveness in Europe. The UK government plays a fundamental role in the UK's AI and innovation landscape, as it helps fund projects led by industry players, often through Innovate UK.

Government partnerships and projects with industry stakeholders

The UK government supports innovative businesses to develop and use AI-based solutions through a series of publicly-funded projects and accelerator programmes. For example, the Thames Valley Berkshire Live Labs project received £5.5 million in funding from the UK government under the ADEPT (Association of Directors of Environment, Economy, Planning

and Transport) SMART Places Live Labs programme. The project aims to offer AI and data-driven solutions in the areas of mobility, communications, energy, health and the environment. The ongoing project is expected to be completed by the end of 2021 and is being led by telecommunications provider O2, which is responsible for data collection for the other stakeholders. These include Siemens, WAYRA (an open innovation hub), Smarter Grid Solutions (an energy enterprise software company), the University of Reading, and a number of data-driven startups. Two local councils, Reading Borough and Slough Borough Council, are the grant holders.

Similarly, in 2015, the government established the [Centre for Connected and Autonomous Vehicles (CCAV)](#) as a joint Department for Business, Energy & Industrial Strategy (BEIS) and Department for Transport (DfT) unit. CCAV is an expert unit working with industry and academia to make car journeys greener, safer, more flexible and more reliable by shaping the safe and secure emergence of connected and self-driving vehicles in the UK. CCAV invests in innovation and skills to realise the benefits of new transport technologies. The work undertaken by CCAV has enabled joint public and private investment of £440 million. The centre, in conjunction with the DfT, announced in April 2021 that [vehicles fitted with AI-enabled Automated Lane Keeping System](#) (ALKS) technology would be the first types of self-driving vehicles on UK roads by the end of 2021.

Government-supported innovation and accelerator programmes

In November 2020, the government announced a £20 million investment to deliver [Turing AI Acceleration Fellowships](#) for 15 projects to meet today's most pressing challenges, such as reducing carbon emissions and transforming industries that include healthcare, energy and transport. Similarly, the government supports the [Turing AI World-Leading Researcher Fellowships](#), which have been awarded to five world-leading AI researchers: Professor Zoubin Ghahramani (University of Cambridge), Professor Samuel Kaski (University of Manchester), Professor Mirella Lapata (University of Edinburgh),

Professor Philip Torr (University of Oxford) and Professor Michael Wooldridge (University of Oxford). These fellowship recipients are going to:

- Engage with the questions around AI and ethics, and responsible research and innovation (RRI) throughout their activities
- Establish an excellence centre in a strategically important area of AI research
- Lead a programme of AI research, translation and innovation
- Build collaborations with academia, industry and broader stakeholders in the UK and internationally
- Represent and drive forward the UK and international research agenda
- Develop the skills and careers of their teams
- Deliver high impact research for UK society and the economy

Digital Catapult, established as a not-for-profit organisation and partly funded by the government, offers the [Machine Intelligence Garage](#) (MI Garage) acceleration programme that supports AI and machine learning startups. The government recognises the growing compute gap between large-scale enterprises and researchers, making access to compute an issue for both competitiveness and security. MI Garage was featured in the government's AI Strategy as an exemplar for supporting and developing the UK's compute capabilities, under Pillar 1: Investing in the long-term needs of the AI ecosystem.

Digital Catapult's Machine Intelligence Garage (MIG)

Machine Intelligence Garage provides early-stage, UK based machine learning startups with access and support in a number of areas:

1. For more than three years, MI Garage has helped startups accelerate the development of their industry-leading AI solutions by addressing their need for computational power. MI Garage provides up to $100,000 in AWS (Amazon Web Services) or GCP (Google Cloud Platform) credits. Participants also have access to selected computing provider's office hours, and additional technical office hours with Digital Catapult's machine learning technical team throughout the course of the programme.

2. Access to business and investment support. The business mentorship offering is vast, and constantly changes depending on the needs of cohorts. Previous business masterclasses have included: pricing strategy, how to be data compliant (run by the Information Commissioner's Office), and how to pitch to investors. The programme runs various showcases where startups can pitch to a room of investors to raise funds. The programme has a track record for facilitating successful investment rounds for startups.[24]

3. Access to AI ethics consultancy and expertise in responsible innovation. Machine Intelligence Garage is the first startup acceleration programme to provide hands-on ethics expertise to early stage startups. Digital Catapult set up an AI Ethics Committee, an independent group of ethics experts, chaired by Professor Luciano Floridi (University of Oxford) to guide AI ethics in practice.[25] Startups receive bespoke consultancy from experts on tangible changes they can make to their products and services for more conscientious, thoughtful and successful AI.

A recently published impact report on the programme has shown that In the three years since its inception, MIG has helped more than 100 startups over 14 cohorts. Participants have raised more than £52 million from private and public investors, with around 50% having accessed their investment after concluding the programme.

The programme's impact reaches well beyond the financial. Following a survey for participants to assess the three pillars of support provided by Machine Intelligence Garage, Digital Catapult found that:

- 52% of startups had increased their turnover, with an average increase of 150% when including pre-revenue startups, and 311% for companies already generating revenue
- 61% of participants had introduced new or significantly improved products
- 67% had grown their number of employees, with an average of 2.5 jobs created per company surveyed - a significant increase for startups with only a small number of employees
- 46% had introduced new or significantly improved production or supply processes: Machine Intelligence Garage's compute power was rated by respondents as 4.2/5 in terms of its ability to unlock new innovation and optimisation opportunities
- 50% of all respondents rated compute power as 5/5, with compute worth more than £7.2 million delivered in total
- 76% startups said that ethics is a critical and consistent aspect of their organisation's decision-making process
- 94% were either satisfied or very satisfied with their involvement in MIG

Machine Intelligence Garage continues to evolve in line with the challenges faced by AI and ML startups. Yet its mission remains unchanged: to provide early-stage machine intelligence companies with access to game-changing computation power and technical expertise, business coaching, and applied AI ethics consultation.

24 Driving the adoption of AI in the UK, Digital Catapult, 2021
25 Digital Catapult Ethics Committee, Machine Intelligence Garage website

Machine Intelligence Garage startup highlight: GreyParrot

Greyparrot is a machine learning (computer vision) waste recognition system deployed on conveyor belts in recycling and sorting facilities across the globe. It combines visible image data with live image processing and deep learning techniques to recognise and distinguish waste types. Greyparrot equips waste managers, producers and regulators with the actionable insight to increase recycling rates, enhance product value, secure better contracts, and gain competitive advantage.

GreyParrot won a joint £500k grant from Innovate UK, alongside Middlesex University and Paper Round (a waste management company), to accelerate research on the integration of AI visual capability into third party robotics. Such technology will be instrumental to making cities smarter, cleaner and greener. Through the MI Garage, Greyparrot was also supported in raising £2.7 million in investment.

Other similarly public-funded programmes to support the AI ecosystem include Tech Nation's Applied AI six-month growth programme to support UK founders who are applying AI in practical areas. The Open Data Institute (ODI), founded in 2012 and partly funded by the UK government, also runs programmes framed around specific challenges, sector-wide projects, and helps startups accelerate their growth.

Tech Nation's Applied AI programme

Applied AI is one of Tech Nation's growth programmes. Tech Nation is the national network for tech entrepreneurs and its Applied AI programme aims to help UK founders who are applying AI in practical areas, creating real-world impact. The programme is based on peer-to-peer support and the shared experience of later-stage founders.

Founded in 2010, Tech Nation supports UK founders, leaders and scaling companies by providing coaching, content and a supportive community. Tech Nation brings together a network of purposeful founders and philanthropists, progressive enterprises and policymakers, funds and institutions in order to collaborate in building technological innovation. Tech Nation is both publicly and privately funded, receiving 80% of its funding from the UK government's Department for Digital, Culture, Media & Sport, and the rest being generated from sponsorship and paid-for educational programmes.

Spotlight: Government-related AI related players and initiatives

Connected Places Catapult

[Connected Places Catapult](#) is the UK's innovation accelerator for cities, transport and places. In 2019, the Future Cities and Transport Systems Catapults united to form Connected Places Catapult, which provides impartial 'innovation as a service' for public bodies, businesses and infrastructure providers to improve how people live, work and travel. It runs technology demonstrators and SME accelerators to scale new solutions that drive growth and prosperity, and eliminate carbon, and operates across six domains to develop opportunities for innovation within each and build bridges between them: Built Environment; Critical Infrastructure; Decision Making; Mobility; Public Space; and Wellbeing.

Bristol is Open, and Connecting Bristol

Between 2013 and 2014, Bristol received funding from the government's Building Digital UK programme (which aims to deliver broadband networks across the UK), and the Super-Connected Cities programme (made up of £150 million to support UK cities to develop digital infrastructure capability) for the [Bristol is Open](#) (BiO) project. BiO was set up as a joint venture between Bristol City Council and the University of Bristol to develop a test-bed programmable digital infrastructure that launched in April 2015. The project used city-wide infrastructure to evaluate new digital technologies and smart city research and development. This included AI, ML, IoT and 5G.

Since the BiO project, Bristol has launched its [Connecting Bristol](#) strategy that outlines its smart city ambitions from 2020 to 2025, setting out how Bristol City Council will support Bristol's smart city journey. As part of the strategy, the Digital Inspector project investigates how digital technologies can help local authorities to undertake statutory road inspections more efficiently. In partnership with Blackpool Council, Cumbria County Council, the Department for Transport, and technology company Gaist Solutions Ltd, Bristol City Council is trialling the use of high definition vehicle-mounted cameras to collect real-time images of road and path conditions. Bristol City Council is now planning follow-up projects that will further automate the process of identifying road defects using AI.

KnowRisk

Supply chains are vulnerable to exogenous shocks that can create a host of disruptions. The COVID-19 pandemic,[26] staff shortages,[27] civil unrest, geopolitical instability[28] and climate change[29] are all factors that create disruptions within supply chains. A lack of transparency across supply chains makes it difficult to assess the levels of risk at each node and within logistics on an end-to-end basis. There is consequently an urgent need to upgrade and overhaul how supply chain and logistics risks are assessed and mitigated. The [KnowRisk project](#) combines AI and machine learning, distributed ledger technologies (DLT), and geospatial intelligence (GEOINT) to serve this critical pain point for insurance companies, and move towards adaptive and robust supply chains.

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26 [Impact of COVID-19 on the food supply chain](#), Serpil Aday and Mehmet Seckin Aday, 2020
27 [Fears grow as UK factories hit by worst supply chain shortages since mid-70s](#), The Guardian, 2021
28 [Companies try to cut geopolitical risk from supply chains](#), Financial Times, 2021
29 [Could climate become the weak link in your supply chain?](#), McKinsey, 2020
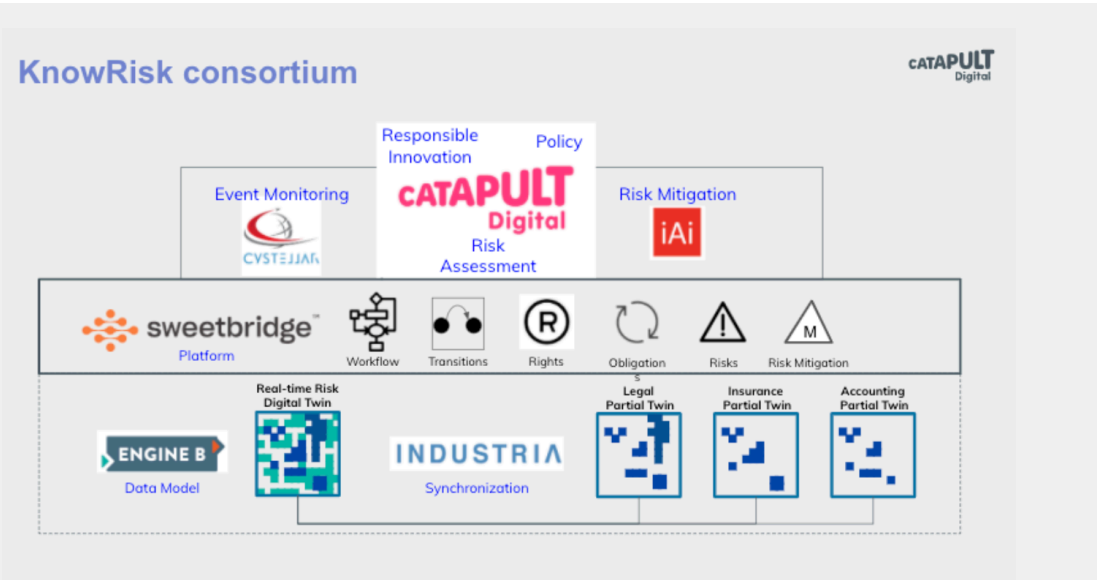
Areas of expertise and responsibilities of consortium members, and key focuses of the project, including obligations, risks and risk mitigation

Innovate UK co-funded the KnowRisk consortium with £2.06 million, and the partner companies include Engine B, Cystellar, Digital Catapult and Intelligent AI, with Sweetbridge as the leading partner. The project developed an open platform that shows how risk inside a business and across the supply chain can be measured, mitigated and insured in real-time through the use of the latest privacy-preserving AI (federated learning), computable contracting and DLT. Its application was piloted in UK construction supply chains and UK food and agriculture supply chains. Within construction, this platform enabled stakeholders to build a detailed understanding of risk, better mitigate risk and create insurance strategies, reducing their completion risk by up to 50%. Overall, the KnowRisk project:

- Built an open-source federated learning library that acts as a prototype for alternative future risk score calculations, allowing the inclusion of current information retrieved from sites
- Was the first opportunity to deliver AI ethics and responsible innovation work as part of a CR&D project: AI ethics consulting for the consortium was organised by Digital Catapult and led by two independent advisors, Professor Burkhard Schafer (University of Edinburgh) and Dr Laura James (University of Cambridge)
- Developed applied AI ethics tools alongside AI development work to increase transparency:scorecards for model reporting adapted for federated learning, and model robustness in the form of mitigation for adversarial attack and corruption
- Engaged government departments, regulatory bodies and businesses from the insurance, audit, construction and food and drink sectors.
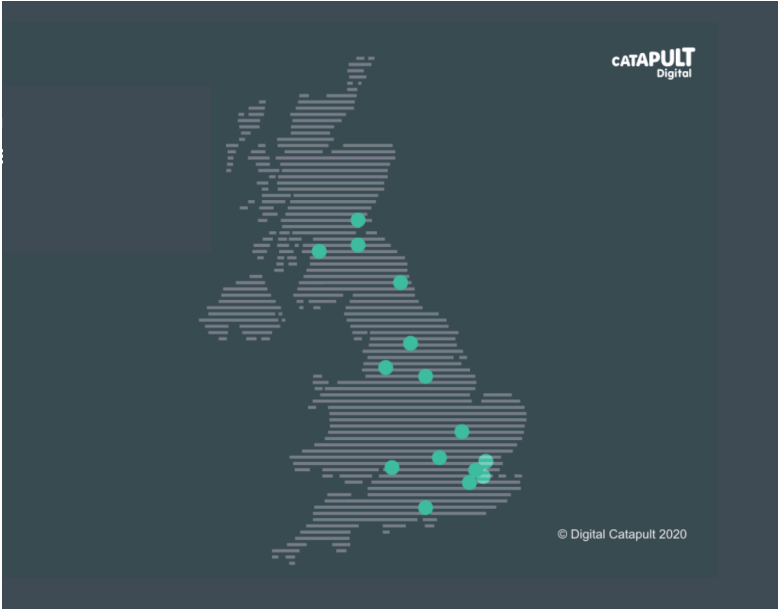
Relevant universities, research, and knowledge centres with a focus on AI

The map below is based on the 2021 university rankings for computer science and AI

Institutions include University of Cambridge, University of Oxford, Imperial College London, University of Southampton, University of St. Andrews, University of Bristol, University of Leeds, UCL Surrey, University of Edinburgh, Durham University, and the University of Glasgow. Please see the Appendix to this report for a subset list of top UK universities for AI and some of their specialisms within computer science and machine learning.

There are a number of expert research institutions in the UK, including the Oxford Internet Institute, that are working to harness the power of AI for enhancing livelihoods and innovation in the UK and beyond. For example, the Ada Lovelace Institute is an independent research institute working to ensure that data and AI work for people and society. It was established by the Nuffield Foundation charitable trust in 2018 in collaboration with The Alan Turing Institute and other expert research bodies, including the Royal Society, the Royal Statistical Society, Luminate, and the industry body techUK. The Algorithmic accountability for the public sector project, in partnership with New York University's AI Now Institute and the multilateral Open Government Partnership (OGP) initiative, seeks to understand the challenges and opportunities of algorithmic accountability policies by focusing on the experiences of the stakeholders and institutions responsible for their implementation.

Opportunities for AI adoption in key sectors

This section highlights key opportunities for AI adoption within logistics and supply chains, and smart cities and transport, and then identifies opportunities for adoption and provides startup case studies by industry focus.

Opportunities in AI adoption for logistics and supply chains

Key priorities for the future of supply chains and logistics include:

1. **Collaboration and information sharing** to help reduce the negative impacts of exogenous shocks and strengthen supply chain adaptability, flexibility and resiliency, optimised using AI and machine learning
2. **Increased transparency and visibility** to monitor the flow of materials and data, with a shared view of processes facilitated by combining technologies such as AI and IoT
3. **Improved risk management culture,** including the collection and storage of event data to help systematise lessons learnt to increase efficiency, facilitated by machine learning, blockchain, and IoT

To achieve the supply chain agility and optimisation of Industry 4.0, it is important to have better visibility of movements within the supply chain network. Good visibility implies monitoring the flow of materials and information across supply chains for a number of benefits, from the faster completion of orders to the optimisation of routes and managing distribution. The following case studies highlight how advanced digital technology startups are benefitting supply chains through enhanced traceability, transparency and management of goods.

Case study 1
Kavida - London-based machine learning startup

Kavida.ai builds digital replicas of supply chains to help enterprises simulate risks across the supply chain, and uses AI for optimal decision support. Using machine learning, it sifts through millions of data points, interpreting unstructured data to uncover hidden threats and disruptions, including monitoring emerging disruptions from across the world.

Using advanced simulations and mathematical modelling, users can quantify the financial and customer impact of real time risk exposure, predict, plan and forecast different scenarios, and minimise the time needed to respond to disruption. The startup also develops automated supplier network mapping to map multi-tier supplier relationships without the need for audits and surveys. By unlocking visibility, enhancing insights and supporting the visualisation of risk, supply chains can be made more resilient in the face of shocks, while still making efficient choices.
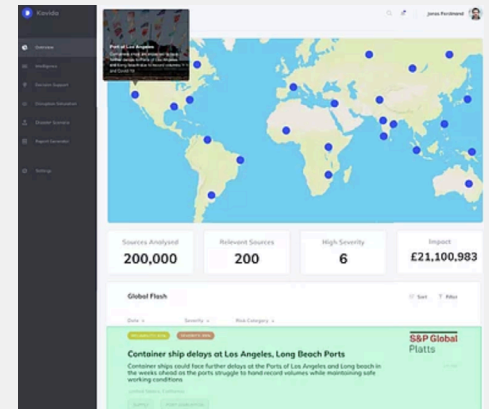
Case study 2
FarmaTrust - London-based machine learning and blockchain startup

The global healthcare and pharmaceutical sector often contains high levels of falsified and counterfeit drugs for human use. In the UK, zzities seized over three million fake medicines and devices worth more than US$13 million.[30] These falsified drugs often contain ingredients that are in the wrong doses, are deliberately and fraudulently mislabelled with respect to their identity or source, and/or have fake packaging, the wrong ingredients, or low levels of the active ingredients, and as such have the potential to cause serious injury or fatalities.

FarmaTrust provides AI and blockchain solutions to support the traceability of medication across end-to-end supply chain logistics operations, in order to reduce the prevalence of counterfeit and falsified medical products. By using blockchain alongside machine learning, the company aims to improve transparency, efficiency and accountability within the healthcare sector and pharmaceutical supply chain. This technology would be applicable to a host of use cases and industries that have logistics and supply chain operations.

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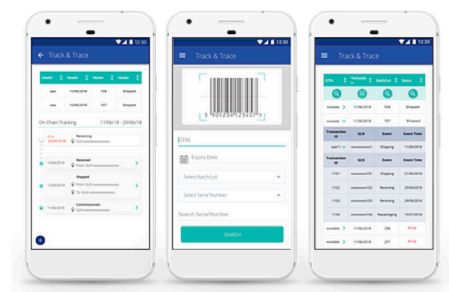
30 [Thousands of fake online pharmacies shut down in INTERPOL operation](#), Interpol, 2021

Opportunities in AI adoption in transport and smart cities

Smart cities have become a common theme for technology applications and use cases in recent years. Alongside these narratives there has also been increasing reference to 'digital cities', which are digital-first, with a focus on offering visitors and residents an intelligent, sustainable and entrepreneurial environment for them to live and work in. The confluence of machine learning, wireless networks and IoT, will foster dynamic knowledge transfers and intelligence between humans, machines and their everyday surroundings.
Widespread deployment of sensors can gather real insights to improve transportation systems, from safety to enhanced resource allocation for sustainability. For example, IoT sensors powered with machine learning and computer vision, coupled with a high speed network, could proactively detect abnormalities in traffic (such as dangerous driving) providing data that can be used to inform city planning and development, or to react to road conditions in real-time, enabling goods to continue moving and ensuring drivers do not remain idle in traffic, thereby reducing a city's carbon footprint. The following case studies show examples of how machine learning startups are developing technologies to serve transportation to make cities smarter, as well as better serving under-represented communities.

Case study 1
## Alchera Technologies - Cambridge based IoT and machine learning startup

Alchera is a cloud-based machine learning software that powers enterprise-grade intelligent mobility and infrastructure applications. It provides operators and commercial users of road infrastructure with real-time data on vehicle and pedestrian movements around cities and major infrastructure at extreme scale. This software operates with greater coverage, lower cost and with greater reliability than any existing solutions, by fusing together existing sensor networks (such as CCTV, IoT, mobile, connected car, etc.) to build an enriched comprehensive single data feed and deliver real-time digital twins. Such solutions are especially useful for tracking optimised routes of distribution vehicles, ensuring they do not sit idly in traffic, as well as seeing the most effective way to reach various drop-off points. This startup is also working on a number of projects to enhance provision of public transport in various cities.

REAL-TIME MOBILITY DATA
FOR RESPONSIVE SCHEDULING

Case study 2
CityMaas - London-based machine learning startup

CityMaas is a machine learning-enabled platform that bridges the knowledge gap in transport and mobility access for individuals with disabilities. The platform is easily searchable for accessibility information and relevant travel information before a trip. This enables business communities to be inclusive, as well as empowering individuals to make more comfortable journeys within cities.
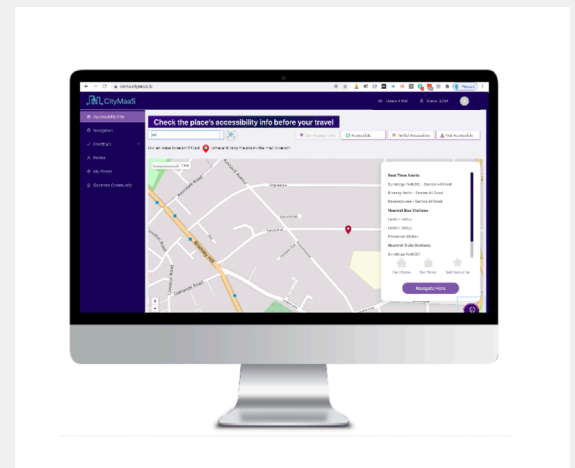
Case study 3
Mobilized Construction - Cardiff-based
machine learning startup

Mobilized Construction provides real-time city-wide data to identify road deterioration before dangerous and costly road hazards arise. Mobilized Construction's analytics provide practical and tactical insights for cost-effective road network management strategies by gathering data across the entire road network every 0-7 days, providing a real-time snapshot of road deterioration.

Barriers to the adoption of AI

The opportunities offered by AI and machine learning are clear, but there are barriers to achieving them. This section outlines some of the challenges in adopting AI (demand-side issues). These challenges are felt across the globe by pioneers looking to experiment and deploy AI systems at scale, and it is important to understand them in order to overcome them more effectively. They can be summarised as: roving return on investment; legacy systems and data availability; long outsourced IT contracts, and resulting technical debt; scalability; and company culture.

This section also explores the challenges faced by the supply side of the technology: AI startups selling their services to industry. The innovator community is always ahead of established industries, and can therefore face acute challenges. One significant barrier to entry is the lack of trust in AI systems.

Emphasis on proving return on investment (ROI), and immediate returns/benefits

Within industrial applications such as logistics and supply chains, adoption of technology is mainly about ROI and immediate business value added. Across the board, industrial and manufacturing sectors are not concerned with following trends in innovation: the drive is around use cases offering clear benefits. There is typically a pressure on the return on investment to be faster (within the same quarter) rather than at a later stage (within the next few years). This means that these companies are typically more challenge-focused, opting for technology that enables them to achieve specific goals within a reasonable timeline. Executives at large companies interviewed as part of Digital Catapult's domain expertise (and across the literature) highlight how they are time-constrained when demonstrating the benefits of an AI system, as the immediate success of a project and ROI is perceived as essential to get buy-in from senior management and other critical stakeholders. Globally, companies struggle to maximise the financial benefits of AI, with 40% of AI projects losing money or breaking even.[31] Even

for those that succeed, the average ROI is currently less than 2%, and the average time to see the results of an AI investment is around 17 months. This is also the reason why some interviewed companies reported investing in other types of innovation, from Customer Relationship Management (CRM) systems to using IoT sensors on-site.

Data availability and legacy systems

The structural problems in data collection and legacy systems is no small challenge for many companies. Data needs to be structured and collected in a specific way for it to be applicable to train AI algorithms. A number of large established companies admit[32] having antiquated technology stacks where the data simply would not be usable for AI. While IoT seems to be more popular as an adopted technology for different supply chain and distribution hubs, deployment of IoT on top of these tech stacks

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31 Driving ROI Through AI, ESI Thoughtlab, Deloitte, Cognizant, et al., 2020

32 Digital Catapult's independent market research (Chatham House rules apply)

does not necessarily integrate or mesh with existing data. Data is stored in a number of different ways, from handwritten submissions to Excel spreadsheets and applications using software and ERP (enterprise resource planning) systems.

Considering this at scale, with hundreds of different hubs (often in different countries), even if transformation using machine learning is desired and well understood, it can still be perceived as a challenge. This is a challenge felt globally: updating legacy systems and levelling out global data management processes has been a critical barrier to enabling advanced innovation.

This problem is further compounded by companies' unwillingness to share data.[33] Data is viewed as extremely valuable, and sharing it is perceived to be a loss of competitive advantage. However, data is not intrinsically valuable: it must be structured correctly, as well as in sufficient volume. The reluctance to share data inhibits the ability of companies to develop and establish AI-ready datasets. Lack of useful data has also been cited as one of the top challenges for companies developing and adopting AI in the Netherlands.[34] This highlights an internationally shared pain point.

Outsourced IT contracts and resulting technical debt

Some companies report challenges in being tied to a long-term IT service contract, which also impacts data storage capabilities. Previous moves in outsourcing IT to third parties can create issues for companies years later. Changes to how data is stored or structured can prove to be lengthy, and require intervention from the outsourced company. Some executives mentioned[35] that they did not have control over this data, limiting its usability and value. This is a significant barrier for companies that are now interested in developing AI solutions and systems.

Perceived enterprise challenges in working with startups: scalability

When asked if they would consider working with startups to implement machine learning, respondents said that they were open to this in principle. However, a perceived barrier to working with startups was the scalability of the solution,[36] and whether the same product would have success in multiple contexts.

With legacy systems and various machines in different locations, the usability and scalability of the potential solutions was put into question.

Culture in uptake of technology: readiness

There is general risk aversion within traditional industries worldwide, and a reluctance to make changes to company structure. In some instances, businesses reported a lack of uptake from employees, even when management had invested in a new piece of technology. Some companies mention a difficulty in long-term use of newly implemented technologies: when new machine learning platforms are integrated, usage consistently decreases over time. For companies where digital processes are not ingrained into daily work practices, the transition to digitised processes can be challenging. This is one of the reasons that building strong use cases through understanding product-market fit and human-centred design (such as intuitive user interfaces) is a critical part of AI development.

Perspectives from the AI startup community

Through Digital Catapult's unique position in the AI ecosystem and startup network, the challenges that AI startups face when selling their products and services become very clear. A key barrier to sales and acceptance of new products is often a lack of trust in the AI system. Interestingly, this holds true for AI products and services where barriers to entry are low, including established AI use cases such as prediction (which may not be predicated on the buyer having their own AI-ready datasets). For AI startups developing more established AI use cases, this key barrier is experienced as companies not trusting the system or the accuracy of the predictions. While established systems are often less expensive than more advanced AI use cases, adoption barriers are not related to the cost of the solution, but to the cost of the risk associated with deploying an autonomous system - and of the company operating on the basis of the AI-generated recommendations. Consequently, subscription-based, predictive algorithm startups often need to provide a number of free trials and free services to gain traction with a regular client base.

33 New survey finds British businesses are reluctant to proactively share data, ODI and YouGov, 2020

34 Largest barriers for companies to use and develop AI in the Netherlands, Statista, 2018

35 Digital Catapult's independent market research.

36 Why AI companies don't always scale like traditional software startups, Venture Beat, 2020

Recommendations and opportunities for UK-Netherlands collaboration

This section provides an overview of recent AI developments in the Netherlands, general recommendations for the Dutch government in promoting AI, and opportunities for collaboration with the UK.

Overview of recent AI developments in the Netherlands, and parallels with the UK

The Netherlands published a Strategic Action Plan for AI, also known as the AI Strategy, in October 2019. This represents the most recent Dutch government policy document focusing on AI. The vision of the **Dutch AI Strategy** relies on three strategic pillars:

- **Capitalising on societal and economic opportunities:** policies encouraging the adoption, use and development of AI in the private and public sector, and promoting the use of AI to tackle societal challenges
- **Creating the right conditions:** policies supporting education and skills development in AI; fostering research and innovation in AI; facilitating the access to qualitative data; and improving the digital infrastructure
- **Strengthening the foundations:** including policy actions related to ethical issues such as trust, human rights, consumer protection and safety of citizens

These pillars are close to those of the UK's AI Strategy, creating a basis for further engagement between the UK and the Netherlands. In October 2019, the Dutch Ministry of Economic Affairs launched the Netherlands AI Coalition (NL AIC), bringing together over 400 participants from the business community, government, academia, research institutions and civil society, including IBM, Philips, and KLM; universities including Delft University and Amsterdam University, numerous

small-to-medium enterprises, and research and technology institutions TNO and CLAIRE.
The coalition is working towards a number of objectives, including realising and testing ten applications within sectors/areas representing the Dutch AI coalition; creating practical and supported ethical frameworks and guidelines for AI development and applications; and promoting data sharing. Like the strategy pillars, these objectives are aligned with the UK's AI Council ambitions. The AI Council's independent expert committee, detailed on page 11, provides advice to the government and high-level leadership of the UK's AI ecosystem, and published the AI Roadmap. Its members come from industry, public sector and academia and its three main areas of focus include developing and strengthening public understanding of AI to boost confidence in this technology within business and society; increasing skills in AI, and the diversity of people studying and working in AI; and exploring how to develop and deploy safe, fair, legal and ethical data-sharing frameworks.

The Dutch AI Coalition has also formulated the AiNed programme, which aims to promote access to AI talent and skills, and high-value public data. Its goal is to facilitate AI-driven business development and promote large-scale use of AI in government, and it envisions creating socioeconomic and ethical frameworks and guidelines for AI. The AI Coalition collaborated with civil society organisations as part of the Ethical Legal and Societal Aspects (ELSA) labs approach, using large-scale

databases and algorithms to find solutions to social issues, such as the prevention of poverty and debt. Once more, there are parallels with the UK, specifically with the CDEI's areas of research, among others.

The multiannual AiNed programme requires a total investment of €1.05 billion from the Dutch National Growth Fund over the period 2021-2027, match-funded by the private sector. On 9 April 2021, the Dutch Council of Ministers actioned phase 1 of the AiNed programme, allocating €276 million for 2021-2022. The funding is intended to accelerate the implementation of AI in the Netherlands, with a focus on transport, logistics, energy and healthcare. On top of the €45 million annual basic funding provided by the central government for AI research and innovation, various government departments decided to co-finance the AI Synergy Theme as part of the National Science Agenda (NWA). Government support is also provided for initiatives such as the National AI Police Lab, Civic Lab, and Small Business Innovation Research (SBIR) pilot projects involving AI in the public sector. For example, to investigate how AI can be responsibly used by public authorities, the city of Amsterdam launched open AI registers that track how algorithms are being used within its municipality. The AI registers project aims to ensure that the AI used in public services operates on the same principles of responsibility, transparency and security as other local government activities. A white paper on Realising AI transparency and civic participation in government use of AI was published in September 2020 as best practice for other public bodies wanting to be transparent about their use of algorithms and AI. Similarly, 13 Dutch government bodies received funding from the Ministry of Internal Affairs to develop a public register of algorithms used within the Dutch government, including how they work and how they are developed. The Netherlands was one of the first countries to start developing such national algorithm transparency measures - this is also being advanced in the UK, where the Algorithmic Transparency Standard was recently published by the Cabinet Office's CDDO.

In June 2021, the Dutch government published a special edition of the Dutch Digitalisation Strategy (DDS) which outlines the progress made in AI development and deployment in the Netherlands since the June 2020 edition. The House of Representatives has committed to setting up a Parliamentary Standing Committee on Digital Affairs.

Finally, the European Commission recently published its long-awaited proposal for a legal framework on AI, the Artificial Intelligence Act. The Commission put forward a regulatory framework with the following objectives:

1. Ensure that AI systems placed on the European Union market and used are safe and respect existing law on fundamental rights and Union values
2. Ensure legal certainty to facilitate investment and innovation in AI
3. Enhance governance and effective enforcement of existing law on fundamental rights and safety requirements applicable to AI systems
4. Facilitate the development of a single market for lawful, safe and trustworthy AI applications and prevent market fragmentation

The proposed rules will be enforced through a governance system at member state level, building on existing structures, and a cooperation mechanism at Union level with the upcoming establishment of a new enforcement body, the European Artificial Intelligence Board (EAIB). Additional measures are also proposed to support innovation, in particular through AI regulatory sandboxes, to reduce the regulatory burden, and to support SMEs and startups. The European Parliament and member states will have to adopt the Commission's proposals and once adopted, the regulations will be applicable across the EU. Once applied, this regulation will affect the innovation and implementation of AI systems and products in the Netherlands as well as bilateral engagement with the UK. Similarly, the EU's forthcoming Data Act, aimed at facilitating data access and use and reviewing the rules on the legal protection of databases, might have similar implications for bilateral engagement, especially as the UK recently unveiled its post-Brexit data regime.

General recommendations for the Netherlands on AI innovation and adoption

Keeping the above strategies, funding commitments, and regulations in mind, Digital Catapult recommend the following actions:

Recommendation 1:
Build closer relationships between the Netherlands and key UK government bodies to develop shared policy learnings on AI and innovation.

These key bodies should include: the Office for AI, UK Research and Innovation (UKRI), the AI Council, and the Centre for Data Ethics and Innovation (CDEI). These relationships should explore areas such as industry adoption of AI and innovation, startup and scaleup support, and standards development and ethics. A closer relationship with key policy players could be particularly useful given the Netherlands' shared commitment with the UK to the ethical use of AI in the public sector, and the UK government's mission to develop an AI technical standards engagement toolkit as part of the global AI standardisation landscape. The UK government will also be publishing a white paper in 2022 on a pro-innovation national position on governing and regulating AI, which could benefit from international lessons learned.

Recommendation 2:
Launch bilateral funding mechanisms for AI innovation and R&D.

Bilateral funding mechanisms would build and strengthen direct avenues for collaboration and knowledge sharing between industry, innovators, academia and the wider innovation ecosystems in both countries. Such bilateral programmes and activities will create lasting trade and research relationships on key areas of common interest such as sustainability and ethics, and would achieve policy objectives in both countries. The UK's AI Strategy commits the UK government to work with global partners on shared R&D challenges, and to include trade deal provisions in emerging technologies including AI, while the

Netherlands is strengthening bilateral knowledge exchange with like-minded countries on AI through various innovation missions.[37] Both countries are also part of the Global Partnership on Artificial Intelligence (GPAI).

Recommendation 3:
Set up a UK-Netherlands AI industry innovation and adoption forum.

This annual forum would bring together representatives of the UK and Netherlands AI innovation ecosystem to set out a roadmap with recommendations updated on a yearly basis. The aim would be to stimulate adoption of AI in areas such as sustainability and net zero, healthcare, logistics and supply chains, smart cities, and advanced cyber physical infrastructure. Forum outcomes could feed into the UK government's forthcoming joint Office for AI-UKRI programme to stimulate the development and adoption of AI technologies in high potential, lower-AI-maturity sectors, as well as the forthcoming National Cyber-Physical Infrastructure Framework.

Recommendation 4:
Explore, build and deliver AI demonstrators for industry and innovation players in both countries.

Leveraging the strengths of the UK's Catapult Network, and AI-related programmes from Digital Catapult, the creation of bilateral AI demonstrators would enable key Dutch and UK industrial players (who could act as challenge owners) to connect with relevant stakeholders in the UK and Netherlands innovation ecosystems in a meaningful way. These demonstrators would showcase carefully selected

UK and Dutch innovative startups and enable them to attract investment and strengthen the startup community in both countries. This would encourage further bilateral activities, allowing the UK Catapult Network to work with startups,

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37 As stated in the recent Dutch Digitalisation Strategy (2021), the government has increased bilateral knowledge exchange with countries including the United States and Singapore, and is working bilaterally with Belgium, Germany and France. As part of its bilateral work with Germany, the Netherlands has launched the German-Dutch 'virtual' field lab AI4DT where SMEs can test and apply AI in combination with 'digital twins'.

scaleups and industry from both countries on specific industry areas (energy, smart cities, healthcare and more), solving UK-Netherlands industry challenges while demonstrating AI and other technology-enabled solutions. This would open up opportunities for both countries to attract FDI and demonstrate export strengths.

In addition, Digital Catapult recommends exploring shared learnings on the following themes for AI:

1. **Joint UK-Netherlands industrial net zero R&D and innovation initiative**

AI and machine learning are of significant importance to both the UK and the Netherlands. This game changing set of technologies is driving innovative solutions to business, environmental and societal challenges, including global net zero goals, as the world seeks to meet the objectives agreed at COP26 in Glasgow. International collaboration in this area is vital to success. Both countries should aim to connect organisations across their innovation ecosystems as a basis for bilateral AI demonstrator projects that showcase how AI can enable and support industrial net zero, for the future sustainability and resilience of supply chains.

2. **Joint UK-Netherlands data sharing initiative**

The most AI-advanced sectors have access to, and use rich, reliable and relevant datasets. This is the first step to developing 'good' AI. The Netherlands and UK should explore different models for data sharing, including bilateral R&D and innovation activities that allow industry to trial advanced machine learning techniques enabling privacy preserving data sharing, such as federated learning. Other avenues could include areas such as upskilling programmes focusing on what constitutes high quality and relevant data, and how to use it. These avenues may be further explored with the support from organisations such as The Alan Turing Institute, Digital Catapult and the Open Data Institute.

3. **Lower the barrier to entry for machine learning startups**

The UK and Netherlands should work together to create bilateral schemes for AI startups and scaleups to connect, helping them to share learnings, and possibly collaborate. This should ensure that AI startups from both countries are technically and commercially supported, connecting them to the appropriate funding and venture capital (VC) communities from both coun-

tries, as well as accelerators and incubators, depending on the need. This could leverage existing capabilities in both countries, such as the TNO and the AI Coalition in the Netherlands, and Tech Nation and the Catapult Network in the UK.

4. **Support Dutch and UK AI ecosystems to explore new markets through existing forums**

The UK and Netherlands should facilitate ways for existing forums for AI startups and scaleups to connect to large corporates in both countries, and enable better engagement with, and exploration of, new markets. Both are critical for developing a product-market fit, and ensuring that the machine learning innovations they are building can be applied to sectors that benefit the economy and society in various countries. These connections are also important for the corporate adopters of AI technologies, enabling them to learn about innovative approaches to problems, and for the innovator community to share learnings. It is important that these recommendations consider ways to foster connections between small and agile innovators and industry challenge owners from both countries, and how this approach can then be disseminated more widely to the sectors where there are clear benefits to AI adoption, but a risk of market and capability failures. This initiative could plug into initiatives such as the Machine Intelligence Garage in the UK and the Tech Nation AI programme.

5. **Support responsible AI innovation by encouraging businesses to embed AI ethics into all product development stages**

For AI to be successful and sustainable, it must be trustworthy and win public trust. This can only be achieved through conscientious and responsible AI development. For this reason, the UK and Netherlands should embed ethics and responsible AI adoption initiatives into any discussions that take place through the recommendations made in this report. While theoretical AI ethics are often discussed at length, it is the practical approach to the development and deployment of responsible and ethical AI that will yield significant results and credibility for both countries in the international market. A practical approach to AI ethics will allow innovators to build resilient, sustainable and responsible AI solutions fit for the future. In the Netherlands, this could take the form of an advisory committee similar to Machine Intelligence Garage's AI Ethics Committee's steering board, which oversees the development of principles and tools to facilitate responsible AI in practice, and its advisory group, which works closely with startups on their AI ethics journey.

Opportunities for engagement between Digital Catapult and the Netherlands AI ecosystem

To achieve some of the recommendations laid out above, some of the projects at the Netherlands' TNO - the independent research organisation focusing on AI, energy transition, industry and other areas, and a member of the NL AIC - could be closely linked to Digital Catapult activities. There may also be opportunities to build a closer relationship with the UK's Catapult Network, which comprises the nine Catapults. This would allow the Netherlands to build on the previous visit of a few Catapult centres to the TNO in 2018-19, and could create broader opportunities that feed into bilaterally-funded projects. Similarly, the AI Coalition's objectives and recent investment from the government could be harnessed to create synergies with various UK initiatives and bodies, such as The Alan Turing Institute (which already undertakes international collaborations) or the Tech Nation Programme, to realise and test some of the applications within the Coalition's sectors and areas. Other regional expert centres such as Amsterdam's AI Hub offer opportunities for bilateral engagement. Amsterdam attracts large pools of AI talent and the Netherlands boasts an advanced academic and research ecosystem. Numerous research projects being carried out in the Netherlands could lead to links with projects taking place in the UK. For instance, the Amsterdam University of Applied Sciences (AUAS) Smart Asset Management Lab aims to use AI to make the maintenance of machines, buildings and mobility (infrastructure, logistics and aircraft) more predictable; make equipment last longer; and schedule personnel more efficiently.

These types of projects are also being carried out at the Digital Catapult (through, for instance, the KnowRisk CR&D project described above) and present opportunities for bilateral engagement. The solutions being developed at the Smart Asset Management Lab could, for example, be featured at Digital Catapult's Made Smarter Technology Accelerator. The programme, delivered by Digital Catapult, supports manufacturers to innovate, invest into and adopt advanced digital technologies. Designed for industry, the programme is a cascade match funding programme for medium and large manufacturers to work with advanced digital technology startups. Digital Catapult works with industry to define the scope of the challenges, select the high potential growth startups and scaleups that can develop solutions, and cascade the funding with technical and industry expert support throughout proof of concept development. The solutions are showcased to the wider sector, with some taken forward and developed into commercial solutions. Similarly, Digital Catapult could join the network of partners at the Dutch Innovation Center for Artificial Intelligence (ICAI), an initiative focused on joint talent and technology development between academia, industry and government in the area of AI, and explore potential bilateral funding mechanisms.

These common priorities and approaches present unique opportunities for bilateral collaborative R&D-funded activities that would foster stronger and mutually beneficial connections in the field of AI. The UK and Netherlands could collaborate on shared themes: AI for net zero, ethical and responsible AI, federated learning to reduce supply chain risks, and AI's potential in unlocking smart city projects.

How the Netherlands can work with Digital Catapult

There are various ways that countries can engage with Digital Catapult on common innovation challenges. These are:

1. **FutureScope Global Challenge**

The Digital Catapult's FutureScope Global Challenge is an international innovation programme designed to strengthen bilateral relationships, foster collaboration and drive forward innovation. Building on the success of the first UK-Canada AI Innovation Challenge in 2018, in 2020 Digital Catapult collaborated with industry partners Siemens and CHEP Europe, and the UK and German innovation ecosystems to challenge pioneering technology startups and scaleups to develop solutions for real-world challenges. In January 2020, the UK-Germany Digital Catapult Global Challenge launched at the British Embassy in Berlin. The event brought together senior representatives from both the UK and German industry to discover more about the challenges and the potential for bilateral collaboration. The pitch day in October 2020 took place online due to COVID-19, and saw the best 12 startups pitch their challenge based solutions to a panel of technology and industry experts. At the end of the event, one winner was chosen per country for both challenges, with the chance to work further with Siemens and CHEP Europe.

The Digital Catapult Global Challenge is typically delivered in partnership with the UK government's Department for Business, Energy & Industrial Strategy and the Department

for International Trade. It is supported by the British Embassy and Consulate network and the UK Science and Innovation Network, along with its multiple international partners. For the Netherlands, Digital Catapult could design and deliver a Global Challenge focused on a particular area of interest, such as AI in supply chains or AI for net zero.

2. FutureScope Global Test Lab

The Digital Catapult's FutureScope Global Test Lab is a bilateral CR&D project that undertakes discovery and challenge definition activities with an overseas corporate and connects their challenges to suitable innovative startups, scaleups and academia from the UK and their home nation. Together, they then all re undertake an R&D project that results in a prototype demonstrator showing how a particular technology can solve real-world challenges for industry. This prototype demonstrator will then be showcased at an event and to the industry adopters of both countries to demonstrate the return on investment, business case for adopting the technology, and examples of how the UK's emerging technology ecosystem can work directly with the partner country.

Digital Catapult has undertaken numerous international CR&D projects over the past seven years and regularly builds prototypes, working with innovators in the UK and multinational corporates. Examples include projects such as the Ericsson Industrial 5G Accelerator, where Digital Catapult worked with Ericsson and plugged Seagate and Tharsus in as industrial challenge owners, before developing prototypes and demonstrators of 5G- related solutions. In AI, Digital Catapult has built prototypes and connected innovative AI startups to challenges from companies such as Rolls-Royce, Thales, P&G and BAE Systems.

For the Netherlands, Digital Catapult could work to develop the first Digital Catapult Global Test Lab: UK & Netherlands, focusing on building an AI prototype solution that solves challenges in supply chains and/or sustainability. This project would start with a phase 1 discovery and project definition scoping exercise through workshops and activities with corporates from the Netherlands and the UK, along with facilitating UK-Netherlands collaboration discussions. Phase 2 would then involve working with partners from both countries to develop a prototype. The timeline for this activity could be: undertaking phase 1 in 2022 (following up on COP26), and phase 2 in late 2022, before being demonstrated to targeted UK and Netherlands industry in 2023.

3. FutureScope Global Scale Up Programme

Digital Catapult's FutureScope Global Scale Up Programme is an international innovation programme that provides small amounts of funding for innovators and corporates to co-develop prototypes before taking them to deployment in a real-world setting. The programme is a multi-year activity that involves challenge owner identification and challenge definition at scale, running open calls to select the right startups and scaleups, prototype development support, investor showcases, demo days for potential customers, and awarding follow-on funding for the most exciting projects. The programme will build on the model for Digital Catapult's highly successful Made Smarter Technology Accelerator, which it delivers on behalf of UK Research & Innovation (UKRI) and the national industry 4.0 programme for the UK, Made Smarter.

For AI startups, the FutureScope Global Scale Up programme provides:

- **Prototype funding** to develop a challenge focused proof-of-concept prototype and supporting materials
- **Peer to peer learning** across a cohort of talented innovators from across the technology sector
- **Business expertise** from a support network of industry and technology experts, to help develop impactful proofs of concept and build new technology prototypes
- **Pitch and industry workshops** focused on helping to develop the concept, and pitch mentorship from the corporate Industry Challenge Owners
- **Networking and support** through the opportunity to work directly with and receive support from industry partners and experts
- **Technical monitoring** and engineering expertise to increase confidence in the prototype build and push the boundaries of the technology, including inputs from Digital Catapult technologists
- **Industry showcase events** that are an opportunity to participate in, pitch and host private demos and meetings with industry members and partners at showcase events
- **Minimum viable product (MVP) funding** for successful competitors from the programme at the end of the prototype phase - this funding allows those companies to further develop their prototypes and present at a final showcase event

Corporates, as industry challenge owners (of any size, but with a challenge related to AI) can benefit from:

- Direct engagement with Digital Catapult as the UK's national innovation centre for advanced digital technologies, and the interface into the UK's AI startup and R&D ecosystem
- Access to curated world-leading AI (or other relevant) startups that can solve long-standing challenges using AI related technologies
- Access to Digital Catapult's wider pool of technology experts, spanning immersive technologies, future networks, and distributed systems
- Opportunities to undertake funded collaborative R&D activities to build AI prototypes with innovative companies from the UK
- The opportunity to showcase their innovations to the wider national sector, and more broadly, to showcase to the international market - demonstrating thought leadership and potentially even new products, services and business models

By providing an overview of the industry, policy and regulatory trends within the AI ecosystem in the UK, this report has allowed for deeper analysis into some of the key opportunities that artificial intelligence, machine learning and related technologies can bring to crucial sectors of the economy, from logistics and supply chains to transport and healthcare.

This report has shown tangible ways in which the Dutch government could engage with the AI community in the UK on common pressing priorities, by building closer relationships with key government bodies and developing shared policy learnings on AI and innovation; ideating and creating bilateral funding mechanisms; and exploring, building and delivering AI demonstrators for industry and innovation players in both countries.

Appendix

The following non-exhaustive list of UK academic and research institutions are renowned globally, and each provides specific AI programmes and initiatives:

The University of Cambridge is one of the leading universities in the field of computer science and AI. Cambridge has a number of specialisms in AI, including using AI within healthcare, as well as the intersection between machine learning and robotics, for example machine learning to help develop 'soft' robotics, to create self healing robots that 'feel pain',[38] and a machine learning-enabled robot that can harvest lettuce.[39] The University of Cambridge also has the Leverhulme Centre for the Future of Intelligence, which is a world-leading AI research centre. Its aim is to bring together the best of human intelligence to make the most of machine intelligence, by highlighting how to approach ethical and social challenges within AI in human-centred and human-friendly ways.

The University of Oxford has a centre that focuses on how AI is being used to support the UN's sustainable development goals (SDGs).[40] The initiative aims to help policymakers (especially those operating within the sustainable development space) tackle SDGs more effectively, by identifying the global problems AI may help solve and recommending tools and best practices for doing so. It will also seek to create a network of socially good AI projects and will aim to draw important lessons from real case studies, in order to advance evidence-based ethical guidelines for future AI projects for social good more generally. The University of Oxford has a subgroup of information engineering and machine learning, Oxford ML Research, which focuses on statistics to handle information in the face of uncertainty within research. The university has two renowned institutes: the Future of Humanity Institute and the Oxford Internet Institute.

Imperial College London is consistently ranked as one of the top ten universities in the world, with a huge specialisation in machine learning and AI. It is centred around the study and development of intelligent and autonomous systems. The focuses are broad, looking at human-machine interaction, augmented reality, computer vision and human modelling. They also place a lot of emphasis on translating computer science research into industry application, and have an Industrial Advisory Board as part of the department to advise on strategic issues relating to research, teaching and interface with industry.

The University of Southampton is also developing AI to better enable the rising numbers of electric cars and trucks - with the numbers accelerating from 1.7 million to 5.3 million, the question is how the National Grid's energy supply would deal with this increase. The university has designed a new pricing system, based on online auction platforms, to optimise vehicle charging.

The University of Saint Andrews in Scotland continues to be one of the UK's top universities for computer science, with a number of AI projects focused on human computer interaction, and using AI for resource optimisation in hospitals. The university also has The AI Research Group, with different research specialisations including constraint modelling.
The UKRI-funded Centre for Doctoral Training in Interactive Artificial Intelligence at the University of Bristol was set up to train innovators, with the overarching aim of establishing an internationally leading centre in responsible, data- and knowl-

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38 Machine learning to help develop self-healing robots that 'feel pain', University of Cambridge, 2019
39 Robot uses machine learning to harvest lettuce, University of Cambridge, 2019
40 Oxford Initiative on AI×SDGs

Appendix

edge-driven human-in-the-loop AI systems. The CDT offers a cohort-based training experience that will equip students with the skills to design and implement complex AI pipelines solving societal problems in responsible ways. The centre has been recruiting since 2019, and the last cohort will be graduating in July 2027.

The University of Leeds is a partner of The Alan Turing Institute, the UK's national institute for data science and artificial intelligence, to conduct research that ranges from fundamental advances in algorithms and understanding of computation, to new display technologies for clinical diagnosis, energy-efficient data centres, and insight into data through visualisation. The university has strong links with the Leeds Institute for Data Analytics, Robotics Leeds and the Leeds Institute for Fluid Dynamics. It also hosts a UKRI-funded Centre for Doctoral Training specialising in artificial intelligence for medical diagnosis and care. The University of Manchester's Institute for Data Science &

Artificial Intelligence acts as an access point to the university's expertise in data science and AI. The institute carries out research as well as hosting seminars and conferences. Its Data Science Club brings together researchers to hear about cutting edge data science methods and techniques being used across the university, the public sector and in business.

The University of Surrey's AI@Surrey is an interdisciplinary collaboration of AI and machine learning across the University of Surrey, and works with a range of UK and global partners from academia, government and industry. It brings together a cross-disciplinary network of centres and groups leading AI-related research and applications: Surrey Blockchain, the Surrey Centre for Cyber Security (SCCS), the Centre for Environment and Sustainability (CES), and the Centre of Digital Economy (CoDE), among others.