ALGORITHM

NATIONAL AI STRATEGY — AI SKILLS & TALENT — NHS AI LAB — APPLIED AI

Version 1.2

ALGORITHM

SHOWCASING ARTIFICIAL INTELLIGENCE IN THE UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND

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The Office for Artificial Intelligence is a joint BEIS-DCMS unit responsible for overseeing the implementation of the National AI Strategy. Its mission is to drive responsible and innovative uptake of AI technologies for the benefit of everyone in the UK. The Office for AI does this by engaging organisations, fostering growth and delivering recommendations around data, skills and public and private sector adoption.

The Office for AI is: Sana Khareghani, Abraham Baldry, Catriona Ross, Claire Chapman, Geoffrey Thornton, Harshaan Sandhu, Iarla Kilbane-Dawe, Jay Ashton-Butler, Kaysar Miah, Nick Swanson, Rachel Meehan, Rose Woolhouse, Sam Hainsworth, Stefan Janusz, Tim Cook, Tracy McManus, Yaa Agyeman and Yohann Ralle.

No robots or AI brains were involved in the publication of this document.

Office for Artificial Intelligence

WELCOME TO THE AGE OF ARTIFICIAL INTELLIGENCE

AI is the fastest growing deep technology in the world, creating huge opportunities to whole new industries, driving substantial economic growth and benefits for consumers, citizens, patients and society in all areas of life.

Our universities and world-leading research base are the ideas factory for a dynamic data generation and through our near £1 billion AI Sector Deal, boosted by the government's significant uplift in R&D investment, we are determined to keep them at the centre of AI innovation.

As we recover from the pandemic we have published a new National AI Strategy to increase resilience, productivity, growth and innovation across the private and public sectors. Furthermore, we're laser-focused in being the leaders for the safe and ethical adoption of this technology.
You will find out how we'll achieve these goals within these pages.

You'll also discover how we're nurturing a new diverse group of AI talent and leaders, and some of the novel ways AI is being deployed. You'll learn about best practices, new thinking and left feeling inspired from top AI company founders.

We hope you enjoy reading about the UK's AI journey so far and - *more importantly* - look forward to where we're heading together next in this age of AI...

GEORGE FREEMAN MP
Minister for Science, Research and Innovation
Department for Business, Energy & Industrial Strategy

CHRIS PHILP MP
Minister of State at
Department for Digital, Culture, Media & Sport

STATE OF

£15.6BN

The UK AI sector is worth £15.6bn and employs more than 35,000 people[1]

> *In 2020 UK firms that were adopting or creating AI-based tech received £1.78bn in funding, compared to £525m raised by French companies and £386m raised in Germany*

> *The UK remains an AI powerhouse, ranking third in leading the world in AI, behind the US and China, and above countries of more comparable size*[2]

259%

In 2020 the number of unique tech jobs advertised per month in the UK outweighed that of key countries in Europe by 259% on average

THE UNION

$15BN

UK tech VC investment is third in the world, hitting a record high of $15bn in 2020 in the face of challenging conditions

^50%

The UK is more attractive to international investors than ever; 63% of investment into UK tech came from overseas in 2020, up from 50% in 2016

> ***London is fourth for tech VC investment globally behind San Francisco, Beijing and New York at $10.6bn***

> ***The UK ranks third, only behind the US and Switzerland, as the countries best prepared to equitably use, adopt and adapt emerging technologies including AI***[3]

All Tech Nation (2021). *Tech Nation Report* Except:
[1] The Data City (2020). *UK Artificial Intelligence Analysis*
[2] Tortoise (2020). *The Global AI Index*
[3] UNCTAD (2021). *UNCTAD Technology and Innovation Report*

"We should be prepared to make commitments to high-risk high-return projects and accept that failure in specific projects is not wasted money; it is the price of innovation success"

Earlier this year DeepMind, a London-based AI company, released AlphaFold and showed its remarkable potential to predict protein structures. The subsequent publication applying this to the entire human proteome was met with stunned appreciation throughout the research and innovation community.

DeepMind changed the world of protein structure determination overnight by making freely available what would have taken decades of work using traditional experimental techniques. It is a landmark moment for the UK and open science community, enabling experts to turn their efforts to use this knowledge to enhance the discovery of new medicines and diagnostics. This in turn will lead to further investment.

If the UK is to be a science superpower in the future we will need to make these examples more systemic, more routine. We have excellent foundations, a skilled and international workforce, a thriving innovation sector, and extensive collaborations across the world. But to maximise the benefits of transformative technologies like AI consideration of the long-term requirements are needed.

Going forward of course it is essential to continue funding fundamental discovery research, providing high quality infrastructure for research and development, and ensure that the UK remains attractive to talent from across the world, and that great careers can be forged here. But in order to tackle complex challenges - from epidemics and pandemics, to climate change and the loss of biodiversity - we crucially will need to do much more to support the translation of science into innovation and implementation, from discovery through to use.

To do this well will require a better understanding within and across government of what we

Innovation and Collaboration key to UK Science future

SIR PATRICK VALLANCE
UK GOVERNMENT CHIEF SCIENTIFIC ADVISER
AND NATIONAL TECHNOLOGY ADVISER

and others have in our "portfolios of science", and needs horizon scanning to anticipate trends – we need a contemporaneous, authoritative and unvarnished view of what we have, what we are missing and what is coming if government policies and R&D funding are to be based on evidence. We must also create a business and regulatory environment in which science, tech and data can unlock potential innovation and an integrated strategy that encompasses finance and incentives, manufacturing, supply chains and procurement of innovation.

Importantly, we must take a business mindset in our decision making and execution. We should be prepared to make commitments to high-risk high-return projects and accept that failure in specific projects is not wasted money; it is the price of innovation success. We must be prepared to create optionality and recognise that not all of our needs can or should be met by domestic science strengths and that we need international partnerships to create access routes for what we might need without buying everything upfront.

Doing this will not be easy. Our collaborations will need to be much wider and deeper than ever before, across a growing number of scientifically advanced countries and across the business, finance, academic and public sectors. We know that to reach our targets for R&D spend will require a significant uptick in investment from the private sector. We also know that accelerating the 'pull through' from research to commercialisation will require new voices from industry and finance to help government usher in its own culture change.

Very strong support for curiosity-driven research is the bedrock, but alone it is not sufficient. To harness our rapid technological development as a force for good in the world, we need to t our knowledge investments into impact. It requires science, engineering and technology to be mainstream within government and to be as essential to policy as economics has become. It requires us to work together across sectors and geographies as a collective. We have exciting opportunities ahead of us, but to realise these opportunities require coordinated action.

The Government Office for Science has recently published a report - **Large-scale computing: the case for greater UK coordination**. This is a review of the UK's large-scale computing ecosystem and the interdependency of hardware, software and skills.

You can access the report at **gov.uk/government-office-for-science**

TECHNOLOGY HAS TRANSFORMED OUR LIVES, AND WILL BE AT THE HEART OF OUR RECOVERY.

OUR TEN TECH PRIORITIES EXPLAIN HOW WE CAN USE IT TO BUILD BACK BETTER, SAFER AND STRONGER, AND SHAPE A NEW GOLDEN AGE FOR TECH IN THE UK.

TEN TECH PRIORITIES

1 GIGABIT BROADBAND AND 5G ARE AT THE CUTTING-EDGE OF DIGITAL INFRASTRUCTURE, ENABLING US TO CONNECT AT LIGHTNING SPEEDS. WE ARE SPENDING £5 BILLION TO MAKE SURE **HOMES AND BUSINESSES ACROSS THE COUNTRY BENEFIT** FROM GIGABIT BROADBAND - INCLUDING THOSE IN HARDER-TO-REACH AREAS. WE WILL ALSO KEEP WORKING TO ENSURE VULNERABLE PEOPLE ACCESS THE SUPPORT THEY NEED TO BENEFIT FROM DIGITAL CONNECTIVITY TOO.

2 **DATA IS THE DRIVING FORCE OF MODERN ECONOMIES**. BY REMOVING BARRIERS TO RESPONSIBLE DATA SHARING AND USE, WE AIM TO BECOME THE WORLD'S NUMBER ONE DATA DESTINATION: AN OPEN, WELCOMING AND SECURE ENVIRONMENT WHERE COMPANIES FROM ALL OVER THE WORLD CAN INNOVATE AND GROW, AND WHERE DATA IMPROVES LIFE FOR PEOPLE ACROSS THE UK.

3 WE WANT EVERY ADULT TO HAVE A BASE LEVEL OF DIGITAL AND CYBER SKILLS SO THAT **NO-ONE IS LEFT BEHIND BY THE DIGITAL REVOLUTION**. OUR APPRENTICESHIPS,DIGITAL BOOTCAMPS AND THE DIGITAL ENTITLEMENT WILL HELP SET PEOPLE UP FOR THE HIGHLY-SKILLED, HIGHLY-PAID ROLES OF THE FUTURE, AND GIVE THEM THE CONFIDENCE TO USE THE INTERNET SAFELY AND SECURELY, WHILE OUR £520 MILLION HELP-TO-GROW SCHEME WILL **EMPOWER 100,000 BUSINESSES** TO ADOPT THE LATEST TECH.

4 OUR DIGITAL ECONOMY IS WORLD-LEADING BECAUSE PEOPLE HAVE TRUST IN THE TECHNOLOGY THAT UNDERPINS IT. OUR ONLINE HARMS LEGISLATION WILL **HOLD SOCIAL MEDIA COMPANIES TO ACCOUNT** FOR THE SAFETY OF THEIR USERS WHILE PROTECTING FREE SPEECH AND EXPRESSION, AND THE FREEDOM OF THE PRESS. WE WILL ALSO IMPLEMENT MEASURES TO MAKE OUR NETWORKS MORE SECURE AGAINST CYBER THREATS, INCLUDING BY LEGISLATING TO ENSURE THAT CRITICAL TECHNOLOGIES OF THE FUTURE ARE "SECURE BY DESIGN".

5 THE UK IS THE TECH POWERHOUSE OF EUROPE, ATTRACTING MORE INVESTMENT THAN FRANCE AND GERMANY COMBINED. OUR **TRAILBLAZING PRO-COMPETITION DIGITAL MARKETS UNIT** WILL BUILD ON THIS INCREDIBLY STRONG FOUNDATION - OPENING UP THE MARKET TO NEW AND INNOVATIVE TECH COMPANIES. BY CREATING THE RIGHT ENVIRONMENT FOR COMPANIES TO ACCESS GROWTH CAPITAL AT EVERY STAGE OF THEIR CYCLE, WE WILL SECURE OUR STATUS AS ONE OF THE MOST ATTRACTIVE COUNTRIES IN THE WORLD TO START AND GROW A DIGITAL BUSINESS.

6 ARTIFICIAL INTELLIGENCE HAS THE POTENTIAL TO FUNDAMENTALLY TRANSFORM OUR LIVES. THE UK ALREADY HAS A STRATEGIC ADVANTAGE IN THIS NEW FRONTIER, AND OUR UPCOMING **NATIONAL ARTIFICIAL INTELLIGENCE STRATEGY**, WHICH WE WILL PUBLISH LATER THIS YEAR, WILL HELP US BUILD ON OUR WORLD-CLASS RESEARCH AND INNOVATION BASE. WE WILL ALSO WORK TO SOLIDIFY OUR GLOBAL LEADERSHIP IN THE DEVELOPMENT OF QUANTUM COMPUTING AND OTHER TRANSFORMATIVE TECH.

7 AS **AN INDEPENDENT NATION** WITH A THRIVING DIGITAL ECONOMY, THE UK WILL LEAD THE WAY IN A NEW AGE OF DIGITAL TRADE. WE WILL ENSURE OUR TRADE DEALS INCLUDE CUTTING-EDGE DIGITAL PROVISIONS, AS WE DID WITH JAPAN, AND **FORGE NEW DIGITAL PARTNERSHIPS** AND INVESTMENT OPPORTUNITIES ACROSS THE GLOBE.

8 AS TECHNOLOGY ALTERS OUR WORLD, **THE UK IS HELPING SET THE NEW RULES OF ENGAGEMENT**. WE WILL CONTINUE TO LEAD GLOBAL EFFORTS TO BOOST DIGITAL COMPETITION, STRENGTHENING OUR REPUTATION AS A PRO-TECH, PRO-INNOVATION BUSINESS ENVIRONMENT. WE WILL USE OUR INTERNATIONAL VOICE AND G7 PRESIDENCY TO SHAPE THE GLOBAL DEBATE ON HOW WE GOVERN TECH COMPANIES; TO CHAMPION OUR **DEMOCRATIC VALUES**; AND TO COORDINATE WORK ON TELECOMS DIVERSIFICATION, ETHICAL AI AND OTHER GLOBAL CHALLENGES.

9 AS WE TURBOCHARGE OUR TECH SECTOR, WE WILL ENSURE LONG-TERM DIGITAL **PROSPERITY IS EVENLY SPREAD ACROSS THE ENTIRE COUNTRY**. MANY OF OUR MOST EXCITING TECH COMPANIES ARE ALREADY BASED OUTSIDE OF LONDON, AND WE WILL CONTINUE TO SUPPORT THESE HUBS BY BUILDING ON REGIONAL INNOVATION, REGIONAL STRENGTHS AND REGIONAL SPECIALISMS, WHILE ENABLING BUSINESSES IN EVERY UK POSTCODE TO SEIZE THE OPPORTUNITIES OF THE DIGITAL ECONOMY.

10 **BRITISH-BUILT** CLIMATE TECH AND CONSERVATION TECH CAN HELP US ADDRESS ONE OF THE GREATEST CHALLENGES OF OUR TIME. IN THE RUN-UP TO COP26 IN GLASGOW, WE WILL SUPPORT THE UPTAKE OF TECHNOLOGIES THAT **REDUCE CARBON EMISSIONS** AND HELP US **RESTORE OUR BIODIVERSITY**, AND GIVE BRITISH BUSINESSES THE DIGITAL TOOLS TO REDUCE THEIR OWN EMISSIONS AS WE DRIVE FORWARD A GREEN INDUSTRIAL REVOLUTION.

AI Masters class of 2021

CO-PRODUCED BY ACCENTURE, ADARGA, AGGREKO, AMPLYFI, BAE SYSTEMS, BERING, CAMBRIDGE CONSULTANTS, CISCO, CYANAPSE, THE DATA ANALYST BUREAU, DEEPMIND, INTEL, KAINOS, PROTECTBOX, QUANTUMBLACK, THE DATA LAB, WELSH WATER, ZEG.AI WITH OVER 50 UK UNIVERSITIES EXECUTIVE PRODUCER DAME WENDY HALL, UK SKILLS CHAMPION FOR AI

AUTUMN 2021

institute of CODING

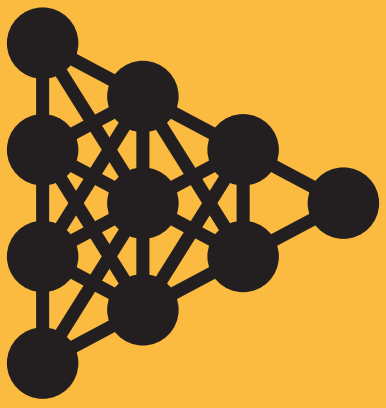
Join leading companies who are helping to support new industry-funded AI Master's places at UK universities. Contact the Institute of Coding for more information on AI Masters: AIMasters.IOC@bath.ac.uk

UK GOVERNMENT TECH PRIORITY

NATIONAL ARTIFICIAL INTELLIGENCE STRATEGY

UNLEASHING THE TRANSFORMATIONAL POWER OF TECH AND AI

OFFICE FOR AI: DECLASSIFIED



X-ECUTIVE SUMMARY

A NEW NATIONAL AI STRATEGY FOR THE UNITED KINGDOM WILL PREPARE THE UK FOR THE NEXT TEN YEARS, AND IS BUILT ON THREE ASSUMPTIONS ABOUT THE COMING DECADE:

THE KEY DRIVERS OF PROGRESS, DISCOVERY AND STRATEGIC ADVANTAGE IN AI ARE ACCESS TO PEOPLE, DATA, COMPUTE AND FINANCE

ALL OF WHICH FACE HUGE GLOBAL COMPETITION

AI WILL OVER TIME BECOME MAINSTREAMED INTO MORE AND MORE OF THE ECONOMY, AND THEREFORE ACTION IS REQUIRED TO ENSURE THAT UK AI DEVELOPERS AND BUSINESSES IN EVERY REGION OF THE UK ARE SUPPORTED TO BENEFIT FROM THIS TRANSITION

INCREASING PREVALENCE IN AI USE WILL LEAD TO AN INCREASING NEED TO ENSURE OUR GOVERNANCE AND REGULATORY REGIMES ARE ABLE TO KEEP PACE WITH THE TECHNOLOGY - IN ORDER TO ENCOURAGE INNOVATION

AND PROTECT THE PUBLIC AND PROTECT OUR FUNDAMENTAL VALUES

SINCE 2011, AI HAS BEEN A CONSISTENTLY TOP-PERFORMING SECTOR IN THE UK[4]

2,000+ AI COMPANIES HAVE MADE THE UK THEIR HOME[5]

£1.06BN IN REPORTED TURNOVER[6]

110,000 UK JOB VACANCIES IN 2020 FOR AI AND DATA SCIENCE ROLES[7]

27% JUST OVER A QUARTER OF PRIVATE AND THIRD SECTOR ORGANISATIONS IN THE UK HAVE IMPLEMENTED AI TECHNOLOGIES[8]

NO.1 DESTINATION

THE UK (18%) AND CHINA (17%) ARE THE BIGGEST BENEFICIARIES OF AMERICAN-EDUCATED AI PHDS WHO LEAVE THE US AFTER GRADUATION[9]

[4, 6] Beauhurst (2021). www.beauhurst.com/blog/ai-startup-companies
[5] The Data City (2020). UK artificial intelligence analysis
[7] Ipsos MORI and DCMS (2021). Understanding the UK AI labour market: 2020
[8] SV and DCMS (2021). Data foundations and AI adoption in the UK private and third sectors
[9] Nathan Benaich and Ian Hogarth / State of AI Report (2020). www.stateof.ai

X-ECUTION TIMELINE

IN THE NEXT 3 MONTHS

STRATEGY LAUNCHED: SEPTEMBER 2021

PUBLISH A FRAMEWORK FOR GOVERNMENT'S ROLE IN ENABLING BETTER DATA AVAILABILITY IN THE WIDER ECONOMY

CONSULT ON THE POTENTIAL ROLE AND OPTIONS FOR A **FUTURE NATIONAL 'CYBER-PHYSICAL INFRASTRUCTURE' FRAMEWORK**

PUBLISH THE CDEI ASSURANCE ROADMAP AND USE THIS TO CONTINUE WORK TO DEVELOP A MATURE AI ASSURANCE ECOSYSTEM IN THE UK

SEEK PUBLIC CONSULTATION ON THE **NHS AI LAB'S DRAFT NATIONAL STRATEGY** FOR THE DEVELOPMENT, IMPLEMENTATION, SCALING AND MONITORING OF AI-DRIVEN TECHNOLOGIES IN THE UK'S HEALTH AND ADULT SOCIAL CARE SYSTEM

PUBLISH THE DEFENCE AI STRATEGY THROUGH THE MINISTRY OF DEFENCE, WHICH WILL INVOLVE THE DETAIL ON THE ESTABLISHMENT OF THE NEW DEFENCE AI CENTRE

THE UK'S NATIONAL AI STRATEGY AIMS TO:

1. INVEST AND PLAN FOR THE LONG TERM NEEDS OF THE AI ECOSYSTEM TO CONTINUE OUR LEADERSHIP AS A SCIENCE AND AI SUPERPOWER;
2. SUPPORT THE TRANSITION TO AN AI-ENABLED ECONOMY, CAPTURING THE BENEFITS OF INNOVATION IN THE UK, AND ENSURING AI BENEFITS ALL SECTORS AND REGIONS;
3. ENSURE THE UK GETS THE GOVERNANCE OF AI TECHNOLOGIES RIGHT TO ENCOURAGE INNOVATION, INVESTMENT, AND PROTECT THE PUBLIC AND OUR FUNDAMENTAL VALUES.

THIS WILL BE BEST ACHIEVED BY THE INVOLVEMENT OF THE DIVERSE TALENTS AND VIEWS OF ALL OF SOCIETY.

IN THE NEXT 6 MONTHS

PUBLISH WHITE PAPER ON A **PRO-INNOVATION NATIONAL POSITION ON GOVERNING AND REGULATING AI**

EVALUATE THE PRIVATE FUNDING NEEDS AND CHALLENGES OF AI SCALEUPS

PUBLISH A REVIEW INTO THE UK'S COMPUTE CAPACITY NEEDS TO SUPPORT AI INNOVATION, COMMERCIALISATION AND DEPLOYMENT

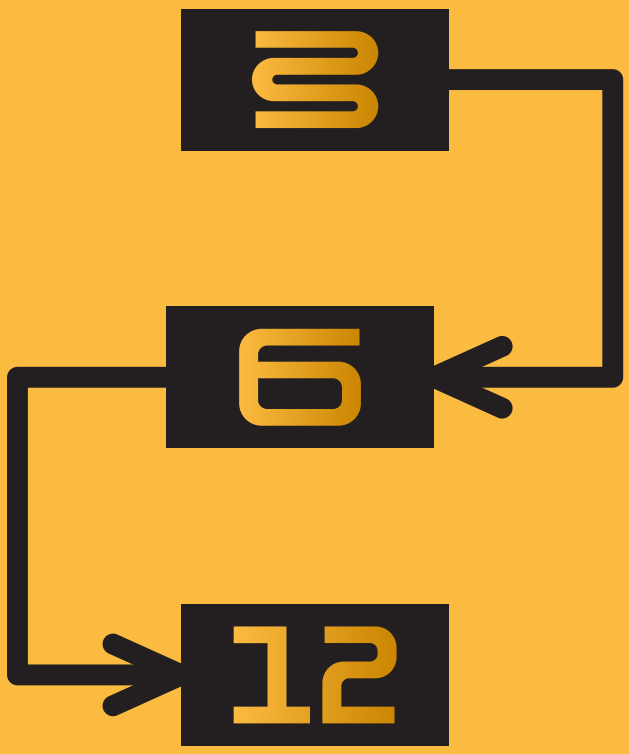
COMPLETE AN IN-DEPTH ANALYSIS ON ALGORITHMIC TRANSPARENCY, WITH A VIEW TO DEVELOP A CROSS-GOVERNMENT STANDARD

IMPLEMENT THE **US-UK DECLARATION ON COOPERATION IN AI R&D**

PUBLISH RESEARCH INTO THE DETERMINANTS IMPACTING THE DIFFUSION OF AI ACROSS THE ECONOMY

EVALUATE THE STATE OF FUNDING SPECIFICALLY FOR INNOVATIVE FIRMS DEVELOPING AI TECHNOLOGIES IN THE UK

CONSIDER HOW INNOVATION MISSIONS INCLUDE AI CAPABILITIES, SUCH AS IN ENERGY



PILOT AN AI STANDARDS HUB TO COORDINATE UK ENGAGEMENT IN AI STANDARDISATION GLOBALLY

EXTEND UK AID TO SUPPORT LOCAL INNOVATION IN DEVELOPING COUNTRIES

BUILD AN OPEN REPOSITORY OF AI CHALLENGES WITH REAL-WORLD APPLICATIONS

ROLL OUT **NEW VISA REGIMES** TO ATTRACT THE WORLD'S BEST AI TALENT TO THE UK

IN THE NEXT 12 MONTHS AND BEYOND

WORK WITH PARTNERS IN MULTILATERAL AND MULTI-STAKEHOLDER FORA, AND INVEST IN GPAI TO SHAPE AND SUPPORT AI GOVERNANCE IN LINE WITH UK VALUES AND PRIORITIES

SEMICONDUCTOR SUPPLY CHAINS - **UNDERTAKE A REVIEW OF OUR INTERNATIONAL AND DOMESTIC APPROACH**

CONSIDER WHAT OPEN AND MACHINE-READABLE GOVERNMENT DATASETS **CAN BE PUBLISHED FOR AI MODELS**

LAUNCH A NEW NATIONAL AI RESEARCH AND INNOVATION PROGRAMME **THAT WILL ALIGN FUNDING PROGRAMMES ACROSS UKRI AND SUPPORT THE WIDER ECOSYSTEM**

WORK WITH GLOBAL PARTNERS ON SHARED R&D CHALLENGES, **LEVERAGING OVERSEAS DEVELOPMENT ASSISTANCE TO PUT AI AT THE HEART OF PARTNERSHIPS WORLDWIDE**

BACK DIVERSITY IN AI BY CONTINUING EXISTING INTERVENTIONS ACROSS TOP TALENT, PHDS, AI AND DATA SCIENCE CONVERSION COURSES AND INDUSTRIAL FUNDED MASTERS

CONTINUE SUPPORTING THE DEVELOPMENT OF CAPABILITIES AROUND TRUSTWORTHINESS, ADOPTABILITY, AND TRANSPARENCY OF AI TECHNOLOGIES **THROUGH THE NATIONAL AI RESEARCH AND INNOVATION PROGRAMME**

MONITOR AND USE NATIONAL SECURITY AND INVESTMENT ACT TO PROTECT NATIONAL SECURITY WHILE KEEPING THE UK OPEN FOR BUSINESS

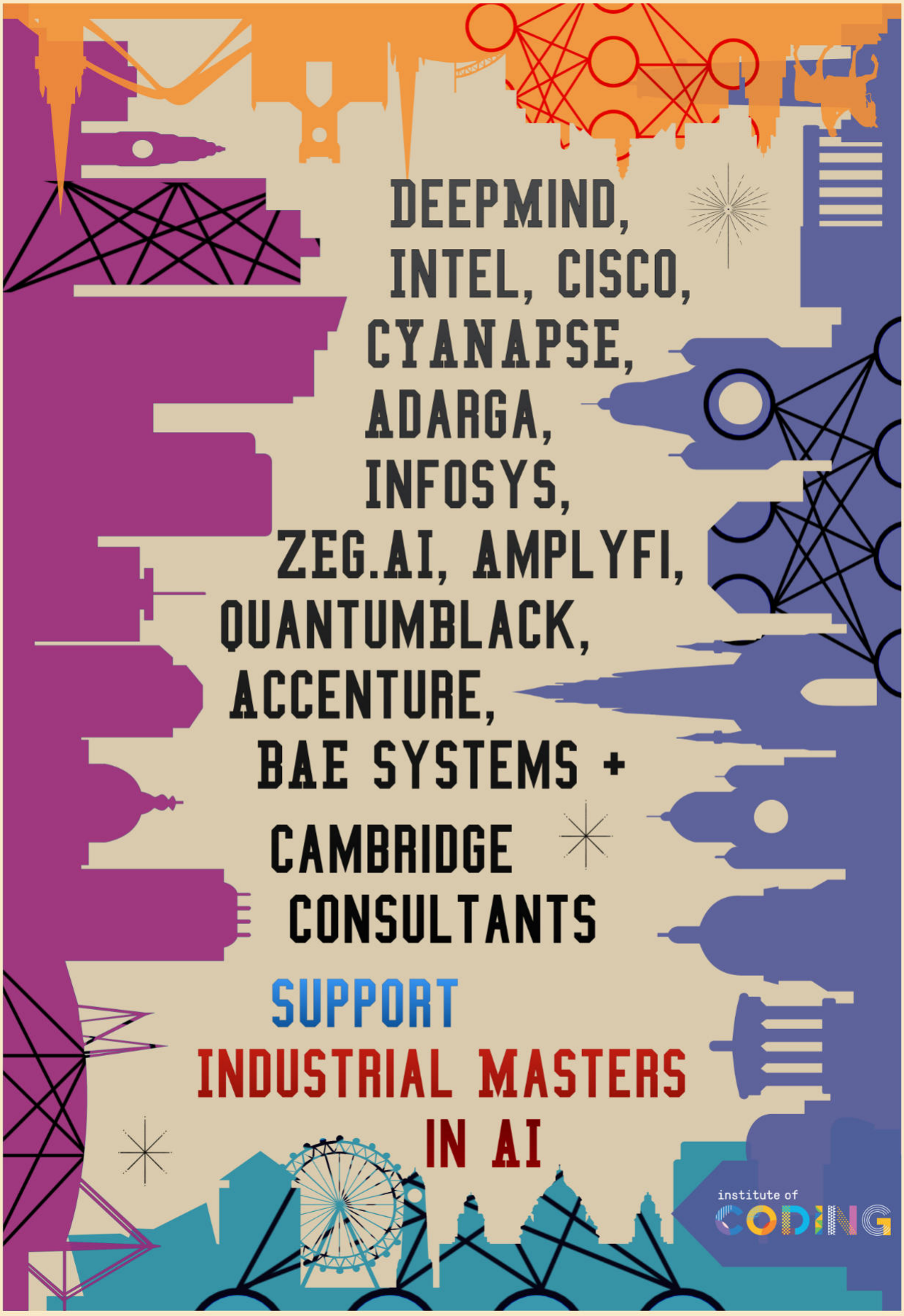
WORK WITH THE ALAN TURING INSTITUTE TO UPDATE GUIDANCE ON AI ETHICS AND SAFETY IN THE PUBLIC SECTOR

WORK WITH NATIONAL SECURITY, DEFENCE, AND LEADING RESEARCHERS TO UNDERSTAND WHAT PUBLIC SECTOR ACTIONS CAN SAFELY ADVANCE AI AND MITIGATE CATASTROPHIC RISKS

"The UK is already harnessing the enormous potential of AI to improve all our lives - from faster and more effective disease diagnosis, to controlling the heating in our homes.

Through this strategy we will nurture our AI pioneers to accelerate bringing new technologies to market, unlock high-skilled jobs, drive up productivity and cement the UK's status as a global science superpower."

BUSINESS SECRETARY, RT HON. KWASI KWARTENG MP



Join leading companies who are helping to support new industry-funded AI Master's places at UK universities. Contact the Institute of Coding for more information on AI Masters: AIMasters.IOC@bath.ac.uk

Working together to ensure AI lifts us all

AI is shaping the world as we know it. Think of it in the context of the pandemic and how it shaped our lived experience and as a result, zoom and teams are common parlance and telemedicine has actually become a reality. Technology can propel us forward in many ways, but it will never be a surrogate for society.

It is up to all of us collectively to ensure technology works for us, rather than the other way around.

Joanna Shields
CEO of BenevolentAI, Co-Chair of the GPAI Steering Committee and Chair of the GPAI Multi-stakeholder Experts Group Plenary

G7 this year saw the UK and the US commit to deepening partnerships in science and technology, and promised to work together to use technology to address inequalities and protect the values of liberal democracies. This commitment could not come at a more important time the world is changing, and that change is being driven by new and emerging technologies like AI.

Technology is accelerating at pace, and shaping the world as we know it. We have all seen this profoundly in our lived experience of the pandemic, with the words 'Zoom' and 'Team' quickly becoming our everyday vernacular. We have also seen the rise of telemedicine and the mRNA vaccine revolution that is just beginning. However, while technology can propel us forward in many ways, it will never be a surrogate for society and it is up to us collectively to ensure technology works for us, not the other way around.

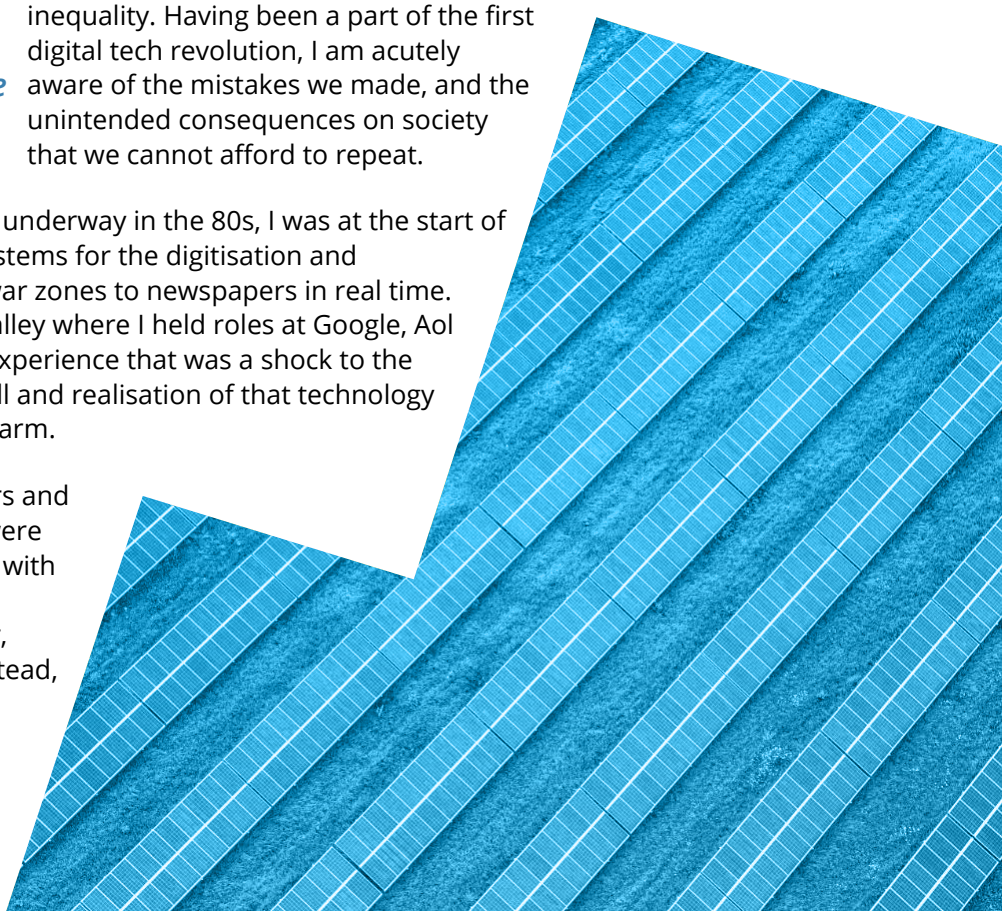
A community coming together

The accelerated adoption of AI by businesses and governments has the potential to change our lives for the better, but multilateral cooperation is key to ensuring this technology is used for the benefit of all. This is core to my work as Co-Chair of the Global Partnership on AI, an international initiative supported by more than 40 countries to advance AI responsibly and ethically and support cutting-edge research. By bringing together world-leading experts from science, industry, civil society, governments, and academia, the GPAI is working to establish a collaborative governance framework to ensure AI truly is a force for good.

By bringing together world-leading experts from science, industry, civil society, governments, and academia, the GPAI is working to establish a collaborative governance framework to ensure AI truly is a force for good.

My inspiration for chairing this global initiative is rooted in my belief that technologies like AI need to lift us all up, and should not be a tool to magnify, accelerate, or exacerbate inequality. Having been a part of the first digital tech revolution, I am acutely aware of the mistakes we made, and the unintended consequences on society that we cannot afford to repeat.

With the digital revolution well underway in the 80s, I was at the start of my career, developing early systems for the digitisation and transmission of images from war zones to newspapers in real time. After this I headed to Silicon Valley where I held roles at Google, Aol and Facebook. It was the last experience that was a shock to the system - a genuine wake up call and realisation of that technology had the potential to do great harm.



In the beginning these founders and early leaders of digital giants were idealistic and well-intentioned, with ambitions to democratise information and create a fairer, more connected world. Yet instead, the philosophy of »

> *GPAI's core objective is to work on the most pressing issues of today's society and ultimately make a difference in the AI international ecosystem.*

'move fast and break things' and maximising monetisation at any cost became the norm, not the exception. During the first two digital decades, there was no blueprint for governing emerging technologies and their societal impact. Consequently, the "unintended consequences" have become some of today's most pressing problems. When it comes to AI, we need to take note of this and recognise that it is not some superpower that will democratise benefits for all unless we steer it towards doing so.

Already we are seeing its threats emerge such as the societal implication of AI bias, and the ethical concerns surrounding its application in surveillance, warfare and its ability to deploy disinformation. As the use of AI grows exponentially, we have a window of opportunity to confront these threats. Governments, businesses and individuals must do better by implementing frameworks for responsible development for the benefit of all and not just a few. AI that reflects the values that make us human - empathy, intuition, emotion, compassion.

Cutting-edge projects in AI

At GPAI, our five expert working groups - Responsible AI, **AI and Pandemic Response**, Data Governance, **Future of Work**, Commercialisation and Innovation – are working on cutting-edge projects across a spectrum of sectors which establish a clear framework to ensure the responsible use and deployment of AI. From climate change, where our Responsible AI group is working with global partners to develop a global AI adoption strategy for climate action and biodiversity preservation, to our Data Governance group which is supporting the creation of real-world data trusts that enable data sharing for social benefit. Our core objective is to work on the most pressing issues of today's society and ultimately make a difference in the AI international ecosystem.

Climate change, health and life sciences (including response to COVID-19 and other possible pandemics), the impact of AI on human rights are all crucial issues that require a bold and ambitious approach - one that can ensure AI serves everyone across the world - and GPAI is set to take this challenge on.

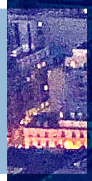
After working for thirty years in tech, what I have learnt is that we can't allow AI to operate unchecked by human values. To use the analogy of a parent and child, humans are the parent that must steer this technology (which is still in its infancy) in the right direction and we need nations and global organisations like GPAI to participate, engage and lead.

We are not even a year into our journey, but I am absolutely convinced that through collaboration between governments and experts in the AI community, GPAI is uniquely positioned to do this and play a vital role in harnessing AI for societal benefit.

GPAI is also more than a group of experts. It is an international ecosystem and community of people from a range of different backgrounds and sectors, who are integral to making this fairer, more inclusive vision of AI a reality. This November, we are welcoming all these groups to our Annual Summit in Paris to share our progress so far, and come together to set an international standard for AI.

We look forward to seeing you all there!

THE ROAD TO PARIS



June 2018
Creation of an International Panel on AI announced prior to the 2018 G7 Summit

The announcement was made by Canadian Prime Minister Justin Trudeau and French President Emmanuel Macron, prior to the 2018 G7 Summit, a key outcome of the Canada-France Statement on AI.

28 May 2020
G7 Science & Technology leaders agree on launching GPAI

During the G7 ministerial meeting on Science & Technology, G7 countries agreed on launching the Global Partnership on AI as a multistakeholder initiative to guide the responsible development and use of AI, grounded in human rights, inclusion, diversity, innovation, and economic growth.

15 June 2020
GPAI launches with 15 founding members

GPAI launches in June with Australia, Canada, France, Germany, India, Italy, Japan, Mexico, New Zealand, the Republic of Korea, Singapore, Slovenia, the United Kingdom, the United States and the European Union as founding members.

Experts from around the globe join GPAI's Working Groups: Responsible AI; Data Governance; Future of Work; Innovation and Commercialisation; and AI and Pandemic Response.

3-4 December 2020
1st GPAI Summit in Montreal

Hosted virtually from Canada by the Montreal Centre of Expertise (CEIMIA), the summit offered a chance for leading AI experts from around the world and GPAI member representatives to participate in sessions, networking opportunities and high-level meetings, including the first meetings of GPAI's governance bodies: the GPAI Council and Steering Committee.

December 2020
GPAI welcomes Brazil, the Netherlands, Poland and Spain as new members

30 June 2021
Mid-Year Rendez-vous

GPAI's Council and Steering Committee co-chairs gave the AI community an update on recent developments and for the Working Groups to publicly launch the AI projects for 2021.

11-12 November 2021
2nd GPAI Summit in Paris

Keep up-to-date with the latest GPAI news at gpai.ai

GPAI

THE ROLE OF AI DATA IN ARTIFICIAL INTELLIGENCE

GPAI's mission is to support and guide the responsible adoption of AI that is grounded in human rights, inclusion, diversity, innovation, economic growth and societal benefit, while seeking to address the UN Sustainable Development Goals.

The Role of Data in AI looked at the importance of data in AI development and identified areas where more data would be useful — that could also be worthy of international collaboration — and where harms may arise due to the collection of or access to data.

Good quality data drives the development of good quality AI products and services

Some points for assessing data quality:

- Data should be fit for use and meet the specifications of each project
- Data should be accurate and complete
- Data should be unbiased and representative of real-world demographics
- Data should be timely — using old data poses a risk to AI development

Impact of data in AI

Data-driven AI raises a number of challenges in terms of its impact on many facets of society:

Societal Impact
Concerns over how data can create new forms of vulnerability by perpetuating and reinforcing inequalities on macro and micro levels.

Environmental Impact
Concerns over growing data-infrastructure, for example, the increasing energy required for running data centers.

Impact on Gender
Concerns over how low quality (missing and biased data) can result in erasing women's voices.

Economic Impact
Concerns over how misuse of data-driven tech could perpetuate economic disadvantage of less-affluent communities.

Data Governance and AI

Good data governance is vital to create accessible, quality data sources for the development of AI products and services that benefits everyone:

Access and availability of good quality data drives collaboration between sectors

Data governance ensures that available language data is curated with re-use in mind and made both FAIR* and open, as far as it is possible to drive development of AI technologies in more languages.

findable, accessible, interoperable and repeatable

Data needs to be accessible at the point in time when it is needed

For example, access to chemical and drug data for AI-assisted drug discovery has identified several known antiviral drugs for the potential treatment of coronavirus infection.

Law and transparency as modifiers to impact of data in AI

Establishing concrete rules to govern data access and sharing among public and private actors benefits the development of AI and increases the flow and availability of data.

Read The Role of Data in AI on gpai.ai

DCC

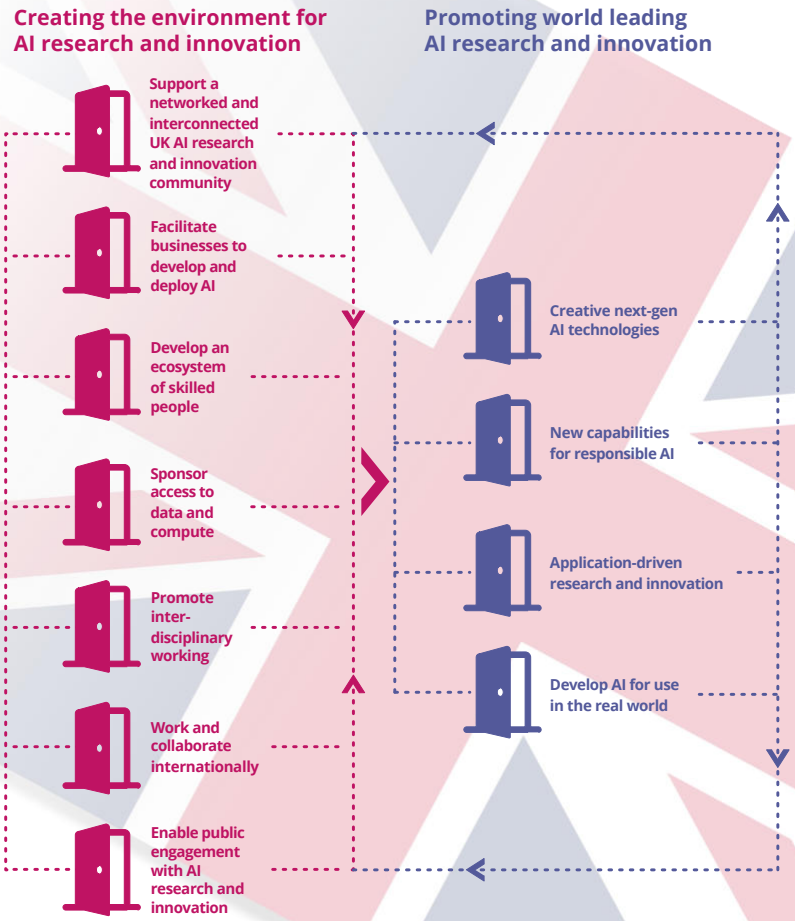
Opening the doors for UK AI researchers and innovators

We are in the midst of an incredibly fast-paced, highly competitive international landscape. **The question before us right now is how to secure national strategic advantage at the right scale of ambition and speed of action?**

Part of the answer lies in looking at the response from our global competitors and partners. Many countries including the USA, China, Germany, France and others are investing heavily in AI and data science. The race is on between the leading R&D nations of the world to establish themselves as magnets for global talent and to become arbiters of international standards.

> *UKRI will work in partnership with a broad range of stakeholders to ensure we maintain the UK's leading position and realise the vast potential benefits of AI.*

The answer also lies in the AI pedigree that we have created in the UK - through our (AI-relevant) investment supporting R&I - and not relinquishing that lead at this critical time.



We already have an enviable position in the fundamentals of new AI algorithms and tools. These will play a key role in economic growth across all regions and nations of the UK; they will be essential to help companies rebuild, revitalise and become resilient.

The know-how in our universities and institutes will help to secure national strategic advantage, so critical in the Government's Integrated Review for long-term security and prosperity. Now, with the publication of the National AI Strategy, is the time to take this to the next level!

Kedar Pandya
Director, Cross-Council Programmes, Engineering & Physical Sciences Research Council

Beware the robot carrying a keyboard

There's a cliché that when AI is written about, it's often accompanied by an image of a robot typing.

The joke, of course, is that an 'AI' robot would never use a keyboard, as typing is a very human activity. But the choice of picture sums up a general confusion around AI. In fact, it could be said the image is direct misinformation - by stoking fears about the capabilities of AI, and of 'AI robots' taking over the world.

Now we cannot just ignore the trust and ethical questions raised around AI - but instead we must engage with concerns directly and demonstrate how AI enhances all of our lives.

The Tech Nation Applied AI programme, created to support the UK's most exceptional AI scaleups, helps us to understand how AI will be

applied in the future, and shows how AI is already being applied to tackle social, environmental, and political issues.

Archangel Imaging, an AI company which has already taken part in the programme, hit the news last year for their work with drone company UVAAid to help stop rhino poachers in Africa. It's creative application of AI will help the survival of one of the planet's rarest species, affecting the diversity of the landscape for a generation. Further examples include: Panakeia, a universal engine for one-step precision cancer diagnosis; ILOF, a company which is creating a digital library of disease biomarkers, helping to find a cure for Alzheimers; and Rahko, one of the world's first companies using quantum computing and AI for drug discovery.

There are many great AI businesses in the UK, and in the last two years, our Applied AI programme has supported over 60 fast-growth AI scaleups. In September 2021, Tech Nation launched it's latest Applied AI 3.0 cohort, with yet more incredible companies which are forging the future. In our 2020 cohort, almost 60% had headquarters outside the capital. This UK wide range is crucial because companies across the UK have the opportunity to develop, learn from each other, access talent, and build new technologies to place the whole of the UK at the forefront of AI innovation.

APPL

Record investment places UK AI companies in prime position take advantage of the roaring 20s and through the Applied AI programme - now entering its third year - we're making sure the momentum is being maintained

Gerard Grech
Founding Chief Executive, Tech Nation

TECH NATION

By the AI ecosystem for the AI ecosystem

Tech Nation's mission is to help scaleup leadership teams reach their full potential, so that they can positively transform societies and economies. We've managed to contribute half a billion pounds to the UK economy through our work.

But we don't do this work on our own. **What makes the UK one of the best places in the world to start, and scale a tech business is the supportive tech ecosystem.** AI experts and industry leaders play a key role in helping us create our sector programmes, so that we can help build the next generation of AI businesses.

Leaders such as Sana Khareghani, the Head of Office for AI, Tabitha Goldstaub, Co-founder of CogX and Chair of the UK Government's AI Council, Dame Wendy Hall, Professor of Computer Science at the University of Southampton, Didem Un Ates, General Manager of Data and AI Acceleration at Microsoft, and Jem Davies, General Manager of Machine Learning Group at ARM - have all played key roles in designing the programme and supporting AI businesses.

Prevailing against the odds

Throughout the challenging year of 2020 and into 2021, AI scale-ups have prevailed against the odds. **Our latest Tech Nation report found that UK deep tech investment is rising at an unmatched rate, up by 17% in a year, while some global competitors have seen decreases in investment.** London remains the second destination for AI global investment after Silicon Valley in the US. We need to keep pushing, to develop more high growth AI businesses, to create more jobs, and to develop more skills.

While I'm not generally in the business of predicting the future, I am in no doubt that this generation of AI companies will be viewed as the pioneers of a new world. To look at, invest in, or work for AI companies in the UK today is to get a glimpse into the next century. But the future will only be shaped by UK based people and companies if investors, political leaders, us at Tech Nation, and many more carry on supporting great UK AI companies. With that, we cannot fail. But however our Tech future turns out, I will guarantee one thing - robots won't be using keyboards.

Applied AI 1.0

Who runs them?

45% of cohort companies have at least one female co-founder

24% of the cohort companies are led by female CEOs

What did they identify as their top 4 challenges?

- Hiring talent
- Storytelling to clients (especially with the most technical applications)
- Raising Series A investment as a Deep Tech play
- Strong in-house technical teams that can lack commercial experience

Archangel Imaging

Smart Security Systems as a Service

Applied AI 2.0

Who runs them?

44% of cohort companies have a female founder

59% headquartered outside of London

Where do they want to expand internationally?

1. United States
2. Germany
3. France and Singapore
4. India and Canada

Peppered throughout these pages are Q&As with some of the exciting AI companies that make up the Applied AI Alumni Network!

Archangel Imaging uses AI at the edge and human-machine teaming to solve global problems like protecting people, animals and infrastructure. They have built AI-enabled cameras which operate in challenging environments and a human-machine teaming platform called Cerebella®. Cerebella® integrates smart cameras and other sensors to detect anomalies, allowing drone, robotic or human staff to respond in real time.

What was a highlight of the Applied AI programme?

Access to high quality content and contacts was superb but what really stood out was how collaborative the programme was. Sharing problems and solutions with other cohort members in similar positions whilst also getting advice from the experts was extremely valuable... and of course the remote socials were a highlight!

How does Archangel Imaging's technology help to combat illegal poaching?

Poaching is a persistent problem threatening the survival of endangered species globally. It is impossible for rangers on foot to patrol every inch of vast protected areas. Our WamCam system for wildlife monitoring and anti-poaching makes AI accessible in remote areas with little infrastructure and connectivity. WamCam gives you extra eyes on the ground and in the sky, using specially trained AI to detect unauthorised individuals. Once a poacher is detected, an alert will be sent via an Cerebella® app to a nearby ranger or drone to investigate in real time, enabling a proactive response to stop poachers in their tracks before they can harm the animal.

And what results have rangers seen by having extra eyes on the ground and in the sky?

We have live anti-poaching projects in parks across Africa where rangers have reported that WamCam has cut response time to poacher sighting from 1-2 hours to a matter of minutes. We have won the AIconics AI for Good award presented at 10 Downing Street for this work and are recognised as working towards the UN's Sustainable Development Goal Number 15: Life on Earth. We have advanced and expanded our capabilities with the integration of new Cerebella® compatible sensors and robotics, like rovers and drones, for current projects such as preventing metal theft and suicide in the rail industry.

archangel.im

SIN: A SCIENCE SUPERNETWORK

With 110 officers worldwide in over 40 countries - 34 in Europe - the UK Science and Innovation Network (SIN) is building relationships across the globe with governments, research communities and innovative businesses, to achieve global goals from tackling climate change to securing the UK's future security and prosperity.

WHAT DOES SIN DO ON AI?

There are a lot of synergies between the UK and Europe. From R&D investment with mature tech sectors in Germany and Israel; being an AI front runner and innovator like France; and striving to be ethically and societally focused like the Nordic countries.

SIN Europe, Turkey, Russia and Israel work across a wide range of topics spanning from climate change and health to emerging technologies. In the last 3 years they've worked with partners to showcase UK's excellence in the use of AI, built substantive partnerships through Global Expert Missions and supported small fund challenges to forge new bilateral R&D partnerships.

SIN leads critical policy exchanges on how AI regulations and policies should address sustainability and climate change; how to increase inclusion and diversity in AI; and how new policies should reflect our values and ethics.

UK Science & Innovation Network

SIN also promotes the UK's association to Horizon Europe which will open up scope for greater collaboration on AI in a multilateral setting crossing a myriad of topics important to our society. »

Where SIN is focusing right now on AI:

- Emerging tech
- Risks and opportunities
- Digital health and personalised medicine
- Manufacturing, future industries and robotics
- Climate change
- AI ethics
- AI regulation
- Data adequacy
- Policy development on AI


ISRAEL
RUSSIA
EUROPE
TURKEY

SIN IN ACTION

Here are just a few highlights over the past couple of years from the SIN Europe team...

COLLABORATION ON AI STRATEGIES

SIN Hungary coordinated an AI study visit for senior officials from the Hungarian Government, including the Prime Minister's Office, and the Hungarian AI Coalition. The group met with key UK AI ecosystem players and **the visit accelerated and influenced the Hungarian AI Strategy** as well as the establishment of the government's new National Data Asset Management Agency, a body modelled closely to the UK's Open Data Institute.

ENABLING AI ADOPTION IN THE NHS

SIN Israel and Innovate UK awarded Israeli startup Zebra Medical Vision and NHS Greater Glasgow & Clyde a grant from the *UK-IL bilateral business led innovation programme*, to develop an AI-driven solution used for the early detection of osteoporosis. Within a year the partnership went on to win a share of the prestigious NHS AI in Health and Care Award, backed by £140 million, to accelerate the testing and evaluation of AI tech for the benefit of health and care practitioners, and patients.

WORKING TOGETHER ON CLIMATE CHANGE

SIN Norway hosted Science Day 2020 in Oslo and set the theme as **'AI as a tool to address climate change and accelerate efforts against a global challenge'**. The universities of Oxford and Cambridge, and Open Climate Fix (a non-profit development lab) presented their leading-edge efforts to tackle global warming using AI. The highlight was the presentation of practical examples of AI applied to monitor deforestation, predict energy demands, and provide novel analysis to help meet the UN Sustainable Development Goals.

SIN Germany, the Climate Policy Team and the Department for International Trade delivered the ***Futures Literacy Lab***. This virtual workshop connected participants from across science, government and industry, and **encouraged the delegates to imagine unforeseeable challenges for climate change, biodiversity and AI, and across multiple and diverse futures**. This creative process led to the identification of new innovation opportunities for UK-Germany collaboration.

INTERNATIONAL COOPERATION IN DIGITAL HEALTH

SIN Germany, Austria, and Switzerland orchestrated a series of events at *Health 4.0 Forum* at the British Ambassador's Residence in Vienna. **The forum fostered international cooperation in digital health, data driven and AI applications in care and cure, ethics, security and legal concerns**.

DEEPENING SCIENCE & INNOVATION PARTNERSHIPS

Over a bustling three-year period, SIN Italy accommodated a series of bilateral exchanges with government and AI researchers. This included a delegation visit to London with Italian government officials and academia stakeholders to discuss reciprocal AI agendas and policy, concentrating on current **AI applications to robotics**.

During the week of International Women's Day 2019, SIN Israel and partners hosted a Women in AI and data delegation to Israel that helped strengthen existing partnerships while **encouraging meaningful deliberations on increasing diversity within in AI and data sciences**.

Visit **gov.uk/uk-science-and-innovation-network** for more information on SIN and follow the link above to the appropriate country if you want to get in touch.

Making a splash on the global AI stage

Over the summer we caught up with techUK's Sue Daley to get her perspective on the current UK AI landscape. During our conversation she reflected on the steps needed to help businesses build back better and the progress that's been made towards ensuring better diversity in the workforce.

UK landscape

What does the current AI landscape look like in the UK?

The UK is home to a thriving AI ecosystem, from innovative start-ups and scale-ups to some of the largest and most successful AI companies in the world. In the last year, we've experienced major scientific advances such as DeepMind's AI-powered protein folding breakthrough, AlphaFold, which offers huge potential to unlock new possibilities in drug design, treating diseases, and environmental sustainability. It is estimated that by 2035 AI could add an additional £630 billion to the UK economy.[10] Yet, despite these well-documented benefits, there is still a lot more that can be done to ensure pace and scale of AI adoption.

What needs to happen next for the UK AI landscape to thrive and grow?

The publication of the National AI Strategy is a vital step in setting a clear vision for how the UK will remain at the forefront of the development and use of ethical and responsible AI. It provides an opportunity to leverage joined up thinking and investment from across industry and government.

From the conversations I've had it seems many SMEs have an appetite to adopt but don't feel able to due to cash constraints. Government support to reduce the financial barriers to digital adoption is necessary going forward to support the long tail of businesses across the UK who could benefit from technologies such as AI. At this current time businesses would also value further guidance from government on how they can use AI responsibly to increase their productivity and reduce costs.

UK competitiveness in AI

What currently makes the UK an attractive place for an AI business?

The UK has a strong offering for businesses looking to relocate and grow in the UK. **We have a well-established academic foundation with a network of world-leading universities and academic institutions, encouraging the creation of university spin-out companies and providing businesses with access to top-talent.** The UK also has a solid reputation for its regulatory expertise and capacity to promote the development and adoption of AI that is ethical, trustworthy, and human-centric. **Equally the UK's vibrant digital ethics community is helping to address some of the biggest, most complex digital ethics challenges resulting from AI technologies**.

How can we increase the UK's attractiveness on a global stage?

The UK is already a global leader in AI but to remain globally competitive we must keep pace. Democratising access to high quality training data is essential for AI research and development. Government must focus on measures to incentivise and facilitate sharing and reuse of data across organisations and between both the public and private sector. Long-term investment in key computing infrastructure such as HPC, AI and Quantum must also continue as these will form the technological foundations upon which scientific research and innovation will be possible. Finally, the ability to attract and retain the best talent from outside the UK remains crucial to the UK's competitiveness in AI. »

Sue Daley
Director of Technology and Innovation, techUK

[10] GOV.UK (2017). *www.gov.uk/government/publications/growing-the-artificial-intelligence-industry-in-the-uk/executive-summary*

Moving forward from the pandemic

What impact has the pandemic had on the UK AI ecosystem?

The COVID-19 pandemic has had a significant impact on our entire economy and society. **In the face of such adversity, we have seen many companies find innovative ways of responding and adapting to changing circumstances and customer demands**. However, many businesses, particularly SMEs, have struggled to keep apace of the changes they need to make to continue to operate. As we learn to live alongside COVID-19, **it is important that government and trade associations, such as ourselves, support these companies as they rebuild their businesses**.

What needs to happen next to help 'build back better'?

As organisations across all industries look to recover, rebuild and perhaps reinvent themselves, AI has an important role to play. We must identify the sectors that are most in need of AI solutions and provide guidance that is easy for organisations of all sizes to follow and adopt. This will help to ensure the benefits of AI are felt across the UK in every sector. The Office for AI recently published *Guidelines for AI procurement* in government, it would be useful to now turn to how we produce similar guidance for the private sector.

What has been your favourite novel use of AI during the pandemic?

One of my favourite novel applications of AI during the pandemic comes from Ocado Technology. The retailer was able to respond and adapt rapidly to the increasing demand for online shopping during the height of the pandemic through its use of smart algorithms. The algorithms detected that by removing the option to buy bottled water online - which used a huge amount of space in delivery vans - Ocado.com was able to serve 6,000 additional customers a week during lockdown, helping to reduce customers' potential exposure to the virus whilst ensuring their family had the necessary food supplies.

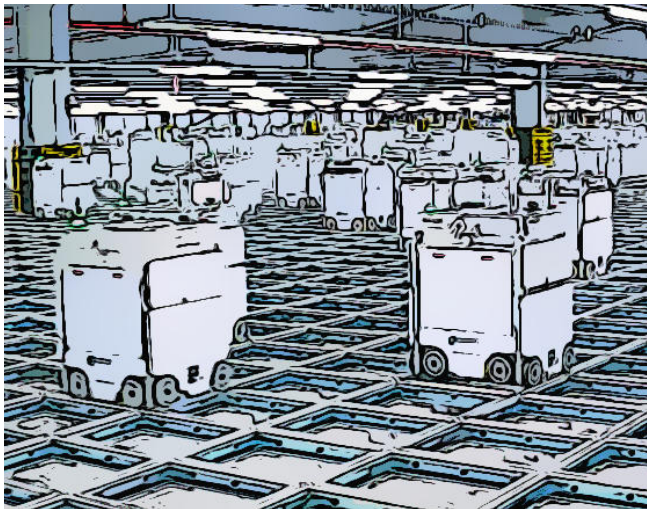
Diversity in the workforce

How much progress has been made towards ensuring better diversity in the workforce?

techUK report *Delivering Diversity* highlights some of the most effective approaches from across techUK membership. We highlight that effective and sustainable solutions must cover all aspects of a company - the people, its processes, and its culture. Our members are themselves diverse, operating across numerous sectors and all with their own individual hiring, training, and retraining practices. The journey these companies are on with their diversity and inclusion practices will be very different. But **by redoubling our efforts to increase diversity in tech we can work towards the normative and societal good of equal representation in the sector** and take important steps towards ensuring an ethical and sustainable approach to the development and use of technology.

What more needs to happen to promote diversity in the workforce?

Promoting better workplace diversity involves a multi-pronged approach from businesses and government. For businesses it is important to concentrate efforts on more inclusive hiring practices such as considering the language used in job adverts and the potential use of blind CVs. Gathering and analysing employee data can be a useful way to identify and address any underlying diversity issues. In addition, government must continue to support and invest in programmes that facilitate greater diversity within the technology sector, building on its current programmes and developing new initiatives where there are gaps.



Over 1,000 robots pack groceries in Ocado's online shopping warehouse.
Photo credit: Ocado Group

To get involved in techUK's Data Analytics and AI programme visit:
techuk.org/accelerating-innovation/artificial-intelligence

Lastly, who are Sue Daley's science superheroes?

As a woman working in tech, **a science and technology hero of mine has to be Ada Lovelace**. Not only for her ground-breaking work but for achieving what she did in the time that she lived in. Also, as a child growing up in the 1980's my interest and excitement about science and technology was really driven by the BBC TV show Tomorrow's World and people like Maggie Philbin who explained and brought to life the amazing power and possibility of what science and technology could mean to all of us in our lives.

THE INDUSTRIOUS CPU . . . THE SOURCE OF AI POWER

British-Canadian computer scientist Geoffrey Hinton was among the world's leading researchers advancing neural networks. Yet those powerful algorithms required trillions of math calculations to make the leap for modern AI. NVIDIA R&D in GPUs has sped this new age...

David Hogan
Vice President Enterprise EMEA, NVIDIA

The worldwide race last year to discover COVID-19 vaccines got a shot in the arm of computational advances to speed the effort to save lives.

Scientists were able to tap into accelerated computing to better visualise, simulate and understand the protein interactions of the SARS-CoV-2 virus that causes COVID-19. A structural understanding of the SARS-CoV-2 proteins promotes better understanding of how the virus infects cells, evades a host's immune system and helps drug development teams better discover new vaccines and therapeutics.

That helped deliver vaccine results within months instead of years.[11]

Photo credit: NVIDIA

Global research from academic and commercial labs to create a more efficient drug discovery process won a prestigious Gordon Bell Prize in November 2020 recognising work fighting COVID-19.[12]

Groundbreaking efforts across industries are now possible with AI running on NVIDIA GPUs.

Early AI x GPU pioneers

Pursued since the 1950s, AI has been decades in the making. It took research from Yann LeCun on convolutional neural nets,[13] Geoff Hinton's approach to training using back-propagation and Stochastic Gradient Descent, and Andrew Ng's large-scale implementation of GPUs to accelerate deep neural networks and ignite deep learning that achieves modern AI.

AI's potential also came into focus when Alex Krizhevsky won the 2012 ImageNet computer image recognition competition, besting human-coded software by a wide margin with AlexNet.

It turned out that the parallel processing of GPUs could chew through data orders of magnitude faster than CPUs. This became an AI game changer for researchers pioneering deep learning.

NVIDIA GPUs paired with the advances in deep learning of the past decade have sparked an AI boom. GPU-driven AI has today changed everything from disease detection to entertainment, banking, retail, agriculture, logistics and cybersecurity.

The worldwide market for artificial intelligence, including software, hardware and services, is expected to increase from $327.5 billion in 2021 to more than $554 billion by 2024, according to research firm IDC. »

NVIDIA & AI: a brief history

1999: NVIDIA invents the modern GPU.

2007: NVIDIA launches CUDA, a programming model that makes using a GPU for general purpose computing and developing AI applications simple and elegant.

2018: NVIDIA launches the Turing architecture - named after Alan Turing – a giant leap in computer graphics that accelerated deep learning training and inference, creating AI applications with powerful new capabilities.

2021: Cambridge-1, the UK's most powerful supercomputer is launched, to help accelerate vital healthcare and life sciences research.

[11] Sharon LaFraniere (2020, 20 Nov). *Politics, Science and the Remarkable Race for a Coronavirus Vaccine*. The New York Times.
[12] NVIDIA (2021). *blogs.nvidia.com/blog/2020/11/19/covid-ai-gordon-bell-winner*
[13] NVIDIA (2018). *blogs.nvidia.com/blog/2018/09/05/whats-the-difference-between-a-cnn-and-an-rnn*

CAMBRIDGE 1

NVIDIA
Cambridge-1
Supercomputer
Photo credit: NVIDIA

NVIDIA in July 2021 launched Cambridge-1, the most powerful supercomputer in the United Kingdom.

NVIDIA's participation represents a $100 million investment, which will boost research at AstraZeneca, GSK, King's College London, Oxford Nanopore, and Guy's and St Thomas' NHS Foundation Trust.

The NHS will also tap into the power of the supercomputer to solve big problems like dementia as well as improve patient care, diagnosis and delivery of critical medicines and vaccines.

The machine will enable top scientists and healthcare experts to harness AI and simulation to accelerate efforts in computational biology and provide support to the country's world-leading life sciences industry.

GPUs and data science research

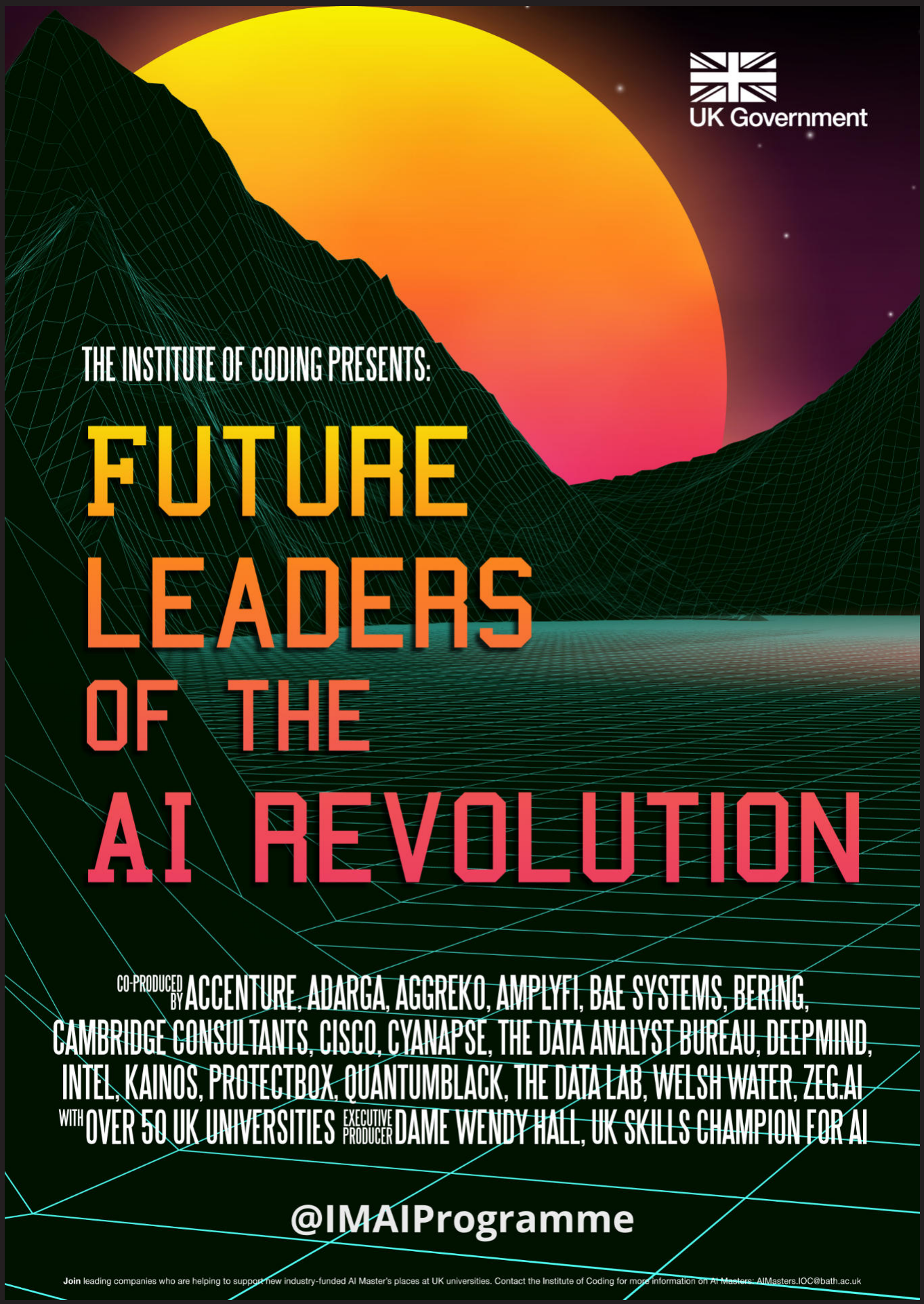
NVIDIA last year announced a partnership with **King's College London** for an open source AI framework, known as MONAI, for healthcare research. MONAI is designed to help medical researchers with healthcare data, handling the unique formats, resolutions and specialised meta-information of medical images. The effort aims to support scientific development of medical imaging AI.

The Francis Crick Institute opened in 2016 and by 2019 launched a centralised GPU cluster to accelerate research in three areas, as the legacy CPU-based cluster couldn't provide the compute power to handle its workloads. They are now accelerating work on HIV and SARS-CoV-2 by better understanding viruses at a microscopic level.

Durham University was awarded the highly coveted NVIDIA CUDA Research Centre. Many research groups across the university have invested in NVIDIA hardware and are training staff to program using CUDA. A wide variety of world leading research with substantial impact has been made possible by this investment from both the university and the UK research councils.[14]

GPUs have transformed the UK's data science research landscape with NVIDIA GPUs driving that change and with Cambridge-1 we are entering an exciting new period of discoveries and deep learning breakthroughs.

[14] Durham University (2021). *www.dur.ac.uk/arc/nvidiacuda*


UK Government
THE INSTITUTE OF CODING PRESENTS:
FUTURE LEADERS OF THE AI REVOLUTION
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WITH OVER 50 UK UNIVERSITIES EXECUTIVE PRODUCER DAME WENDY HALL, UK SKILLS CHAMPION FOR AI
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Join leading companies who are helping to support new industry-funded AI Master's places at UK universities. Contact the Institute of Coding for more information on AI Masters: AIMasters.IOC@bath.ac.uk

The beautiful game just got smarter

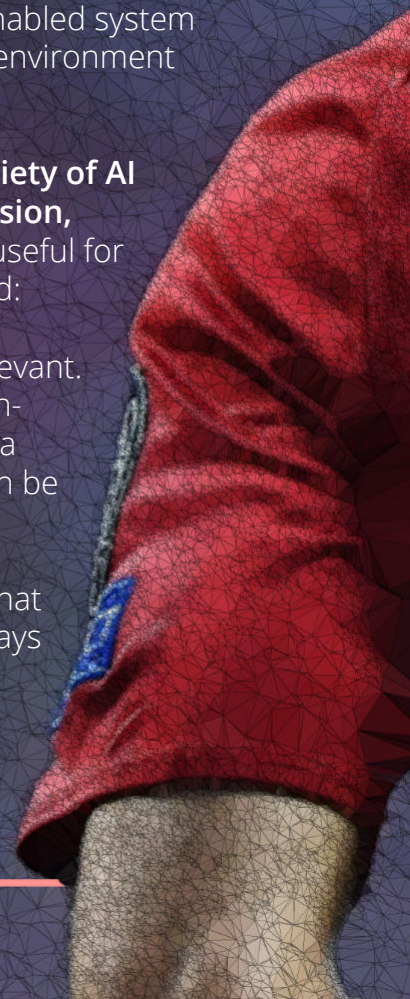
DEEPMIND worked with LIVERPOOL F.C. to envision the future landscape of sports analytics using a combination of statistical learning, video understanding and game theory. Their research illustrated how football is a useful microcosm for studying AI research, and may offer benefits to decision-makers in sports long-term via an automated video-assistant coach (AVAC).

Football - an interesting opportunity for AI

Creating testing environments to help progress AI research out of the lab and into the real world is challenging. Given AI's long association with games, it is perhaps no surprise that sports presents researchers with an exciting testbed in which an AI-enabled system can assist humans in making complex, real-time decisions in a multiagent environment with dozens of dynamic, interacting individuals.

Football analytics poses challenges that are well suited for a wide variety of AI techniques, coming from the intersection of three fields: computer vision, statistical learning and game theory. While these fields are individually useful for football analytics, their benefits become especially tangible when combined: players need to take sequential decisions in the presence of other players (cooperative and adversarial) and as such game theory becomes highly relevant. Moreover, tactical solutions to in-game situations can be learnt based on in-game and specific player representations, which makes statistical learning a highly relevant area. Finally, players can be tracked and game scenarios can be recognised automatically from widely-available image and video inputs.

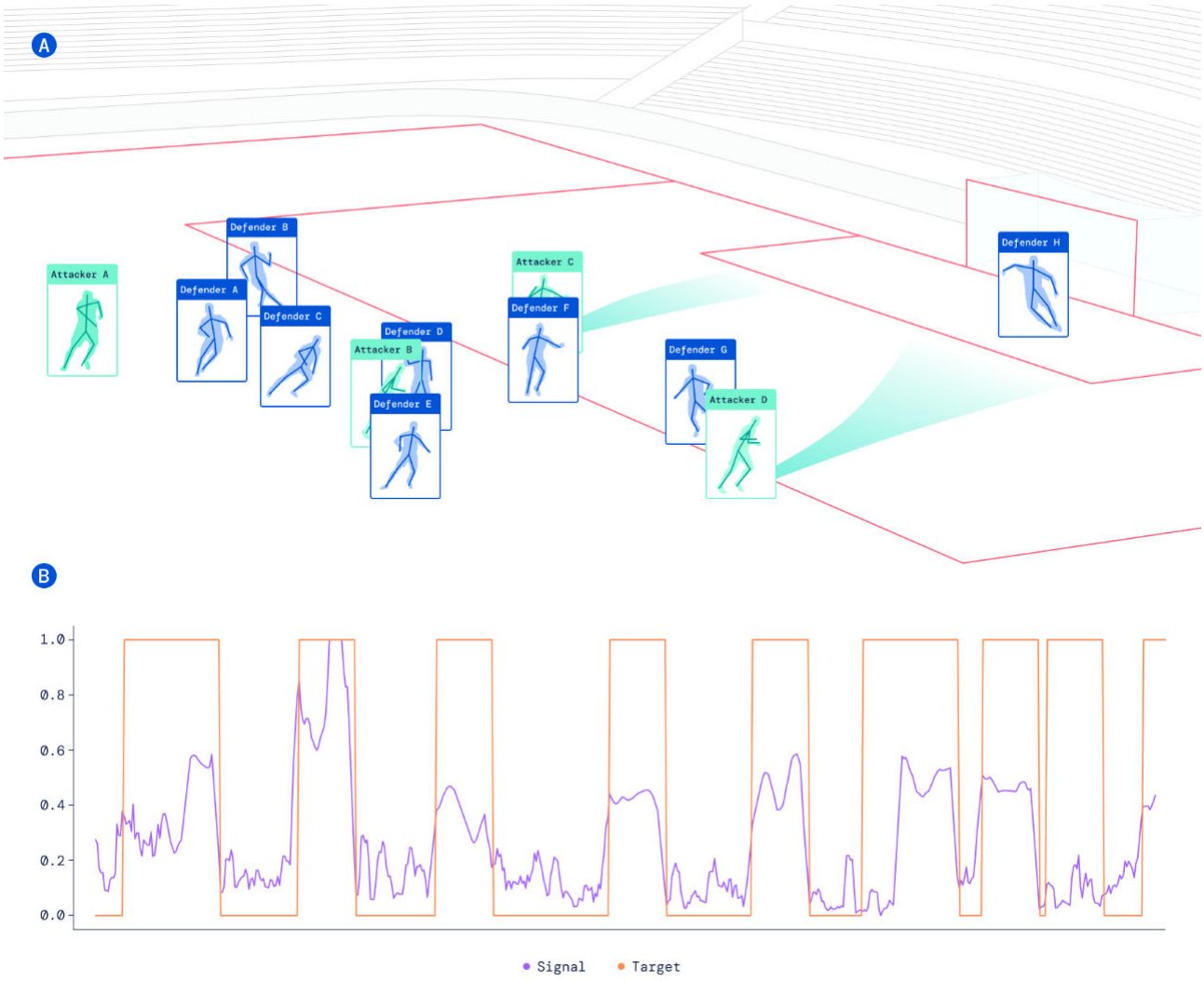
The AVAC system DeepMind envisioned is situated within the microcosm that is formed by the intersection of these three research fields. The research lays out a roadmap for scientific and engineering problems that can be tackled for years to come, and also presents original results at the crossroads of game theoretic analysis, statistical learning, and computer vision to illustrate what this exciting area has to offer to football.



How AI could help football

Game theory plays an important role in the study of sports, enabling theoretical grounding of players' behavioural strategies. In the case of football, many of its scenarios can actually be modelled as zero-sum games. For example, DeepMind modelled the penalty kick situation as a two-player asymmetric game, where the kicker's strategies can be categorised as left, centre, or right shots. To study this problem, it augmented game-theoretic analysis in this scenario with Player Vectors, which summarised the playing styles of individual footballers. With these representations, DeepMind was able to group kickers with similar playing styles, and conduct game-theoretic analysis on the group-level. The results showed that the identified shooting strategies of different groups are statistically distinct. For example, one group prefers to shoot to the left corner of the goal, while another tends to shoot to the left and right corners more evenly. Such insights may help goalkeepers diversify their defence strategies when playing against different types of players. »

Photo credit: Shutterstock



Example illustration of an envisioned automated video-assistant coach interface, where attacking and defending players are detected, identified (in terms of player names), tracked, and subsequently passed into a predictive trajectory model that can be used to analyse potential intents or prescribed trajectories. (B) stylised example of event detection, with a specific target event (e.g. kick) together with the deep learning model output ('Signal') evolving throughout the game.
Image credit: DeepMind

On the side of statistical learning, representation learning has yet to be fully exploited in sports analytics, which would enable informative summarisation of the behaviour of individual players and teams – catalysing further advances in sports analytics. One can study multi-player trajectory prediction, which refers to a data driven analysis of how players could have acted in hindsight, by suggesting alternative player trajectories for a given play and how they might have played out differently. These models also bear potential in predicting the implications of a tactical change.

Finally, DeepMind found computer vision to be one of the most promising avenues for advancing the boundaries of state of the art sports analytics research. By detecting events purely from video the potential range of application is enormous. By associating events with particular frames, videos become

Photo credit: Shutterstock

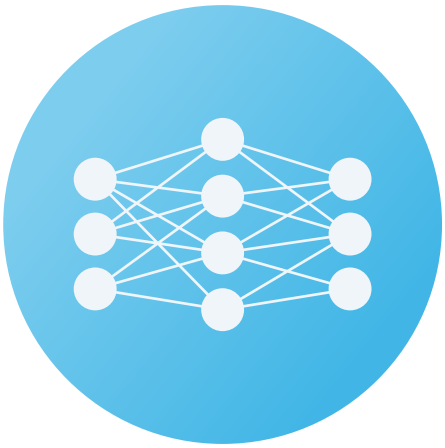
searchable and ever more useful. Football video offers an interesting application domain for computer vision. The large numbers of football videos satisfies a prerequisite for modern AI techniques. Third-party providers also exist to furnish hand-labelled event data that can be useful in training video models and are time consuming to generate, so both supervised and unsupervised algorithms can be used for football event detection.

The application of advanced AI techniques to football has the potential to revolutionise the game for players, decision-makers, fans, and broadcasters. DeepMind also believes that the development of increasingly advanced AI techniques afforded by the football microcosm might be applicable to broader domains.

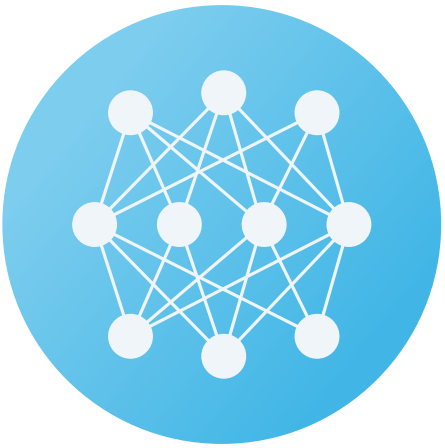
DEEPMIND is a key industry partner with the IoC and the Office for AI, supporting AI Masters students.

How do you know which AI model is the right one for you?

Model A



Model B



Every day, AI is changing how we experience the world. We already use AI to find the fastest route home, alert us of suspicious activity in our bank accounts and filter out spam emails.

The UK Government recognises the importance of this technology's development to both business and the public sector. There are huge opportunities for government to capitalise on this exciting new technology to improve lives. We can deliver more for less, and give a better experience as we do so.

For citizens, the application of AI technologies will result in a more personalised and efficient experience. For people working in the public sector, it means a reduction in the hours they spend on basic tasks, which will give them more time to spend on innovative ways to improve services.

To help leaders and delivery teams benefit from better understanding of AI technology, we have published guides (listed on the opposite page) that draw on best practice from the commercial sector and public sector and are subject to ongoing refinement.

The guides help to explain the opportunities AI presents and the limitations of its use; work out considerations for projects with AI components and decide whether a specific AI product is right for the organisation; and how to ensure the safe and ethical use of algorithms and automated systems.

Putting this readiness into practice and procuring innovative solutions from the UK's thriving tech sector will, in turn, benefit our economy and grow new and innovative markets across sectors.

Maximising the benefits of AI is a priority for government, and the guides are an important step forward towards reaching that goal. We encourage you to put these guides into practice for your organisation.

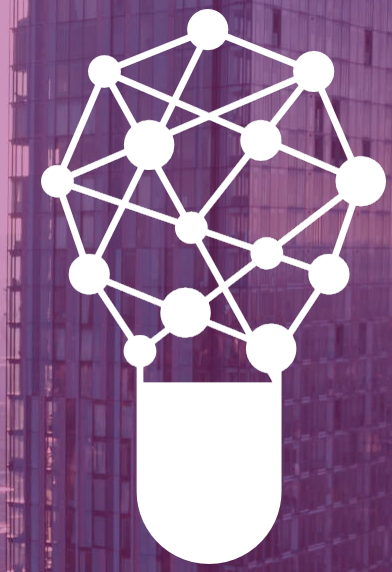
A guide to using artificial intelligence in the public sector

The guide aims to provide practical advice for organisation leads who want to understand the best ways to implement AI solutions and for delivery leads who want to evaluate if AI can meet user needs.

Guidelines for AI procurement

Public procurement can be an enabler for the adoption of AI and could be used to improve public service delivery.

The guidelines, co-developed with the World Economic Forum, provide a set of guiding principles on how to buy AI technology, as well as insights on tackling challenges that may arise during procurement. It is the first of such guidance.



Ethics, Transparency and Accountability Framework for Automated Decision-making

The framework lists seven points that serve as a checklist for any public sector organisation considering automated or algorithmic decision-making systems. If used and followed accordingly it will significantly reduce the likelihood of an algorithmic / automated decision-making related incident; help to build trust; and progress government's effort to ensure the safe and ethical use of algorithms and automated systems.

A Data Trust could help organisations deliver some of the many benefits that better data access can bring – from enabling collaboration on common challenges to creating new products, service or insights.

Data sharing can fuel growth and innovation.

For new and innovating organisations, increasing data availability allows them to gain better insights from their work and access new markets – from charities able to pool beneficiary data to better evaluate the effectiveness of interventions, to new entrants able to identify a product gap in a market. Often this happens as part of commercial arrangements; in other instances government has sought to intervene where there are clear consumer benefits, such as in relation to Open Banking and Smart Data.

The Open Data Institute (ODI), Innovate UK and the Office for AI joined forces to explore a type of data sharing framework called a data trust - a legal structure that provides independent stewardship of data.

Data trusts operate by allowing multiple individuals or organisations to give some control over data to a new institution - the trust - so that it can be used to deliver benefits, for themselves or other people.

That benefit might be to create new businesses, help medical research or empower a community.

By reducing the friction costs of data sharing, we can encourage the safe, fair, ethical and legal sharing of data.

The ODI worked with 3 pilot projects to develop a blueprint for a data trust and then decide how best to take forward the development of the actual trust itself. These pilots focused on diverse challenges: tackling illegal wildlife trade, reducing food waste, and improving public services in Greenwich. The findings and recommendations of these pilots, including a data trust life-cycle to help people build them, are available from theodi.org.

A **data trust** is a legal structure that allows individuals and groups to pool their data, collectively negotiating terms of use through an independent steward who operates with impartiality, transparency, prudence and undivided loyalty.

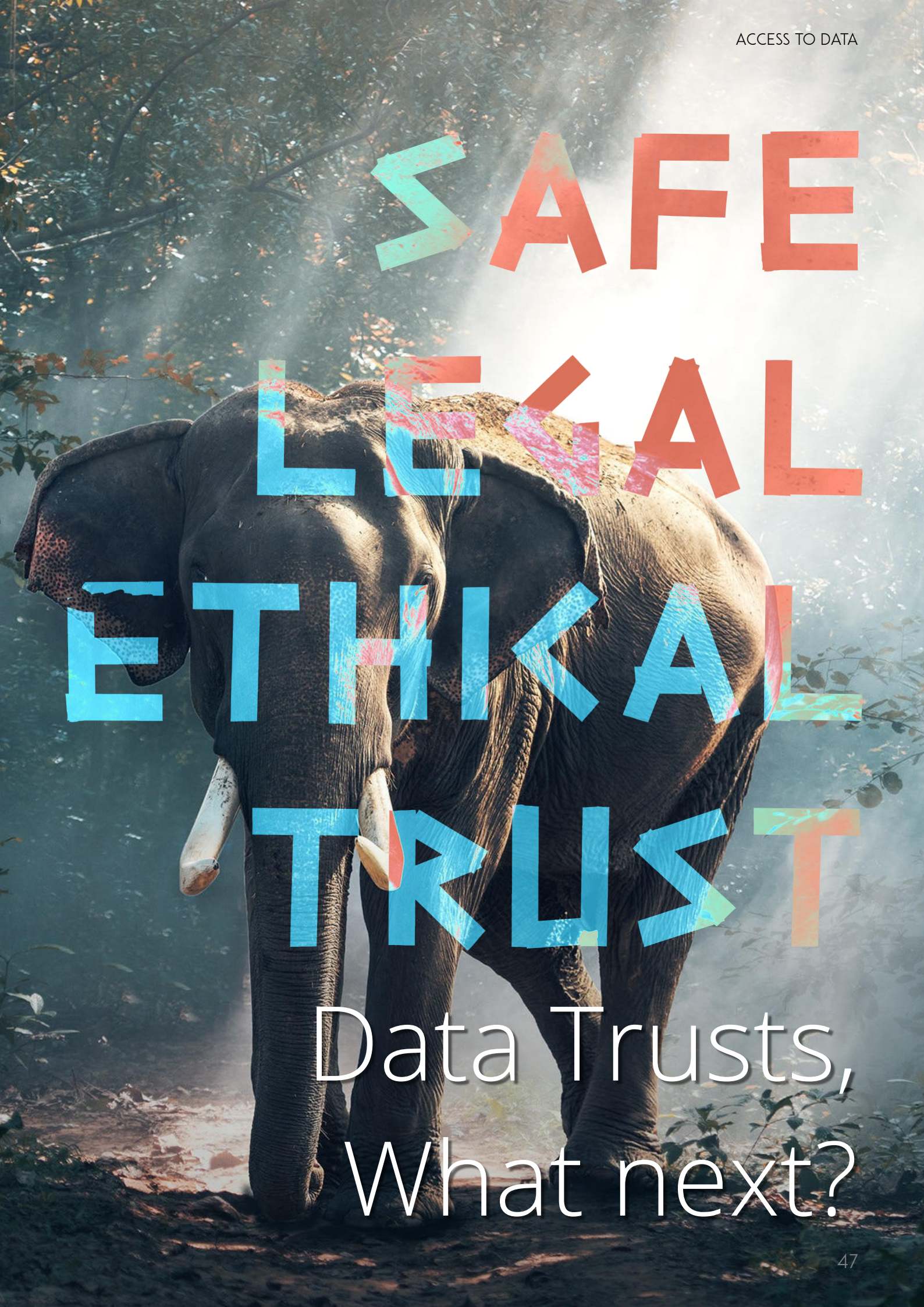
Visit odi.org to learn more about data trusts

The work found a huge demand from private, public and third sector organisations to explore data trusts and other data stewardship models to unblock data sharing. The research focused on the first stages of the data trust life-cycle; scoping and co-design. It found a number of different potential benefits that the data trust approach to data sharing could help to bring.

What's next?

Through the National Data Strategy - which sets out how best to unlock the power of data for the UK - we will continue to explore data trusts and other data stewardship models.

The importance of continuing and furthering this work will be even more vital in ensuring the UK's recovery from the coronavirus pandemic, and its economic success in the years beyond.



Data Trusts, What next?

THE DATA TRUST PILOTS

A **data trust** is a legal structure that provides independent stewardship of data, and **could enable collaborations that use AI to solve challenges**.

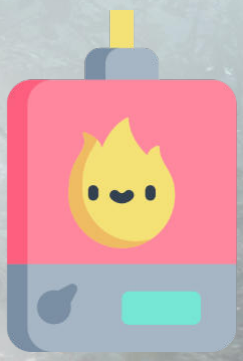
We explored how a data trust could allow conservationists to share data on poacher activity to **combat the illegal wildlife trade**.

This looked at how algorithms can be trained on audio data to detect gunshots, pinging real-time alerts to rangers.

We also identified incentives and blockers for data sharing within food supply chains, **to help food waste reduction** efforts by improving the ability to track and measure waste.

The Greater London Authority and the Royal Borough of Greenwich **explored whether a data trust could improve public services.**

This pilot trialled data-driven tech to help **make less-polluting transport options more attractive**.



It also looked at **improving the energy efficiency of council-owned social housing** using sensors to monitor and control the activity of retrofitted communal heating systems.

Towards a greener grid

Researchers from The Alan Turing Institute contributed to a new solar forecasting system for National Grid, which was 33% more accurate at day-ahead forecasts, helping to improve the balancing of supply and demand and keep consumer costs down.

The National Grid Electricity System Operator (ESO) balances the electricity system in real time, ensuring the nation's supply always meets demand.

This balancing act becomes more challenging as wind and solar power become a larger part of the overall energy mix, as their generation output is hard to predict.

So ESO challenged the UK's brightest talent in data science to investigate how a data-driven approach could help, which led to three Turing PhD interns – with expertise in engineering, maths and statistics – working with ESO.

The Turing interns developed innovative methods and new code. For solar power, they employed a combination of machine learning and computational statistics. **Their models improved on ESO's next-day predictions, and were 10% better at forecasting one week ahead.**

ESO built on this work, using additional machine learning techniques to produce a multi-model forecast. The result was a solar forecasting system 33% more accurate at day-ahead forecasts.

The jump in forecast accuracy is helping ESO run the grid more securely, and more economically, **helping to keep bills lower for all electricity consumers.**

nationalgridESO

With governments around the world looking to promote data sharing while managing harms from data use, there has been growing interest in data trusts as a new approach to data stewardship.

But what is a data trust and what role can they play in data stewardship?

5 things to know about data trusts

1 Data trusts are different from other data institutions

'Data institution' is an umbrella term; it refers to a variety of structures that steward data on behalf of individuals, communities and organisations for an agreed purpose. Data trusts are a type of data institution. A data trust allows individuals to pool their data or data rights in a trust, and task a trustee with stewarding those rights on their behalf. That trustee is bound by the terms of the trust, acting within a framework of robust institutional safeguards to negotiate terms of data use on behalf of the members of the trust. In contrast to other data institutions, data trusts are uniquely positioned to provide independent stewardship of data that supports citizens to exercise their data rights through collective action.

2 Place citizen empowerment at the heart of your data trusts

The bottom-up empowerment of citizens – and, crucially, groups of citizens – is central to the idea of data trusts. This empowerment has social, economic and political dimensions. By pooling together the rights they have over their data, potentially disenfranchised groups not only acquire negotiating power with service providers when it comes to the terms and conditions governing data use; they may also be empowered to effect social and political change through strategic, pro-active data sharing. For this social and political empowerment dimension to bear its fruit, it is crucial that there be a variety of data trusts, each instantiating different aspirations (and attitude to risk).

3 How to make a data trust work will vary from country to country

To create a data trust, individuals need to have rights over data about them that can be held in trust. Countries and regions of the world differ in terms of the rights that are available under current regulations and the legal models that might help manage those rights. In the EU, the General Data Protection Regulation provides a framework for personal data rights, and the forthcoming Data Governance Act is creating a regulatory system to guide the creation of data intermediaries, like data trusts.

4 We need to figure out how to make data trusts work in practice

Much has been written and said about the potential of data trusts by researchers, businesses and governments across the world. The biggest challenge now is to develop real-world data trusts – and to make sure they serve the communities they set out to benefit. Bridging this gap between debate and practice requires further work to design ways of working, develop business models, and create new methods of citizen engagement.

5 We need data trust pioneers

Most of today's questions about what exactly a data trust is or how data trusts work can only be resolved by trialling data trusts methods in practice. We need community leaders that are willing to invest in developing trials and test-bed environments that allow data trusts to innovate safely.

The Data Trusts Initiative is moving data trusts from theory to practice.

By funding research and pilot projects, it is creating new understandings about what data trusts are and how they can address real-world data stewardship needs.

We're currently looking for data trust pioneers that might benefit from funding for pilot projects.

To find out more, visit datatrusts.uk

Sylvie Delacroix
Neil Lawrence
Jessica Montgomery
The Data Trusts Initiative

Ethics and safety in AI

A remarkable time of human promise has been ushered in by the convergence of the ever-expanding availability of big data, the soaring speed and stretch of cloud computing platforms, and the advancement of increasingly sophisticated machine learning algorithms.

Innovations in AI are already leaving a mark on government, by improving the provision of essential social goods and services from healthcare, education, and transportation to food supply, energy, and environmental management. These bounties are likely just the start.

The prospect that progress in AI will help government to confront some of its most urgent challenges is exciting, but legitimate worries abound. As with any new and rapidly evolving technology, a steep learning curve means that mistakes and miscalculations will be made and that both unanticipated and harmful impacts will occur.

In order to manage these impacts responsibly and to direct the development of AI systems toward optimal public benefit, The Alan Turing Institute's public policy programme partnered with the Office for Artificial Intelligence and the Government Digital Service to produce guidance on the responsible design and implementation of AI systems in the public sector.

The guide, *Understanding Artificial Intelligence Ethics and Safety*, is the most comprehensive guidance on the topic of AI ethics and safety in the public sector to date. It identifies the potential harms caused by AI systems and proposes concrete, operationalisable measures to counteract them. The guide stresses that public sector organisations can anticipate and prevent these potential harms by stewarding a culture of responsible innovation and by putting in place governance processes that support the design and implementation of ethical, fair, and safe AI systems.

The guidance is relevant to everyone involved in the design, production, and deployment of a public sector AI project: from data scientists and data engineers to domain experts, delivery managers and departmental leads. Our aim -- and hope -- in writing the guide is to encourage civil servants interested in conducting AI projects to make considerations of AI ethics and safety a first priority

David Leslie
Ethics Theme Lead, and Ethics Fellow,
The Alan Turing Institute

Read the **Understanding artificial intelligence ethics and safety guide** at turing.ac.uk

Reflecting on the first year of the 'Explaining decisions made with AI guidance'

We take a look back on the ICO's work with organisations who use personal data and AI to support, or to make decisions about, individuals.

In a recent ICO survey, **50% of people are concerned about machines making complex automated decisions about them**. In our co-commissioned citizen jury research, the majority of people stated that in contexts where humans would usually provide an explanation, explanations of AI decisions should be similar to ones that would be offered if you were speaking directly to another person.[15]

To help organisations achieve this, the ICO worked with The Alan Turing Institute to produce our 'Explaining decisions made with AI' guidance, published in May 2020. This aimed to "develop a framework for explaining processes, services and decisions delivered by AI, to improve transparency and accountability."

The guidance was produced as a best practice document to help organisations of various sizes from different sectors.

We were clear from the outset that we wanted to make this guidance as practical and useful as possible. This reflects a key ICO aim to enable innovation and economic growth in the AI sector. We can only do this if the guidance we produce is practically applicable to real life situations.

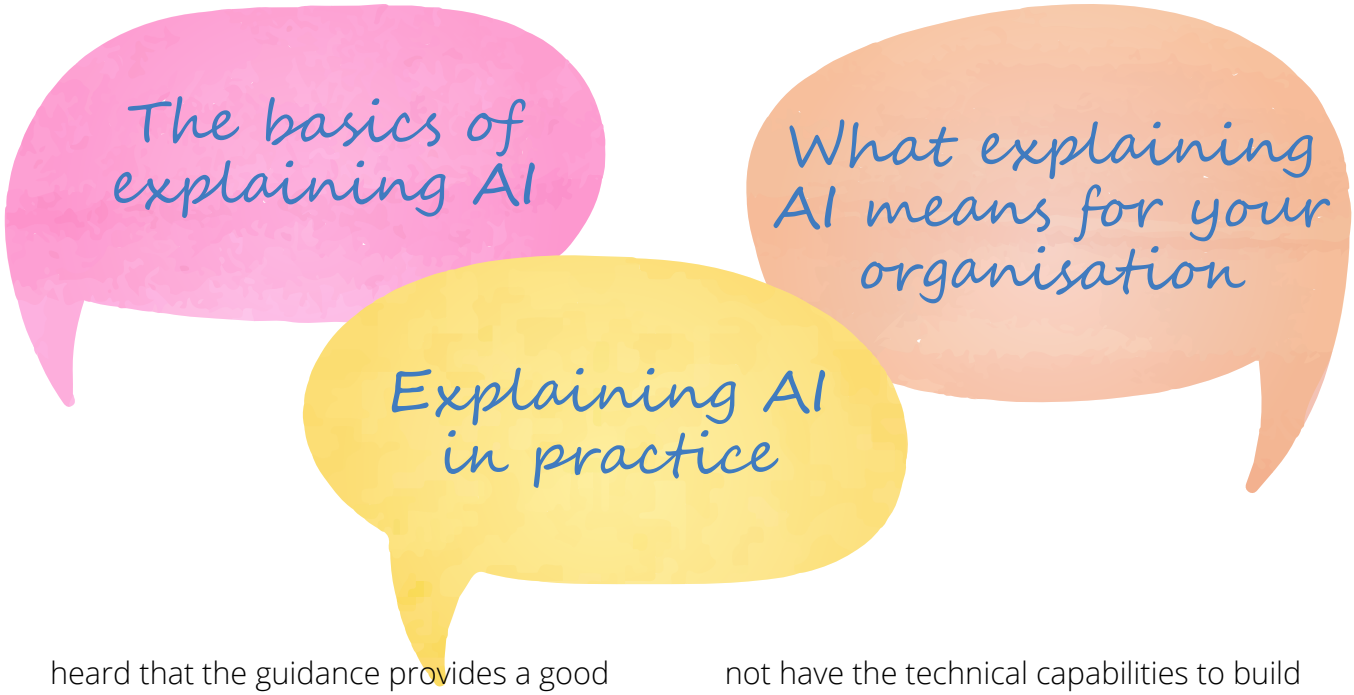
To understand the impact that the guidance has had during the last year, we consulted with 56 organisations who make decisions about their customers using personal data and AI. This group included SMEs, public sector organisations and established technology organisations.

> *The guidance goes into detail about different types of explanations, how to extract explanations of the logic used by the system to make a decision, and how to deliver explanations to the people they are about. It also outlines different types of explanation and emphasises the importance of using inherently explainable AI systems.*

We asked these groups to tell us what worked well, what could be improved, and whether they had any further comments on the guidance.

The feedback was positive, and we are pleased that participants found the guidance useful and of high quality. We

Abigail Hackston
Senior Policy Officer for Innovation, ICO



heard that the guidance provides a good foundation for improving awareness and understanding of the need for explanations relating to AI systems, and how to construct those explanations.

Respondents also said the guidance clearly defined the key elements needed to build explainable AI systems and when further detail was needed this was also easy to understand.

Areas the consultation identified to improve on included the length of the guidance. To address this point and ensure the key parts of the guidance are quickly accessible, we have added the "at a glance" sections separately alongside the guidance as a summary document. This pulls the fundamental elements of the guidance into one place and makes it easier to find them quickly.

> *The feedback was positive, and we are pleased that participants found the guidance useful and of high quality.*

There were concerns raised that some parts of the guidance were not particularly useful for SMEs. It was felt that the level of detail given was more suited to larger organisations, and some additional support may be needed for organisations that do not have the technical capabilities to build and support an AI system in-house. If you run an SME that processes personal data using AI, remember that you can get additional support from the ICO's SME web hub.

We will add some case studies to the guidance, so that organisations can reference some practical examples of good practice in action. Our consultees indicated that this would be a valuable addition. If you feel you have an example of a good case study we might use, we would love to hear from you. Please get in contact with us via AI@ico.org.uk.

We are pleased that the feedback we received indicates that the guidance is having a material impact among the organisations who participated in this consultation. These comments give the ICO confidence that the guidance will be an effective tool for those who choose to use it.

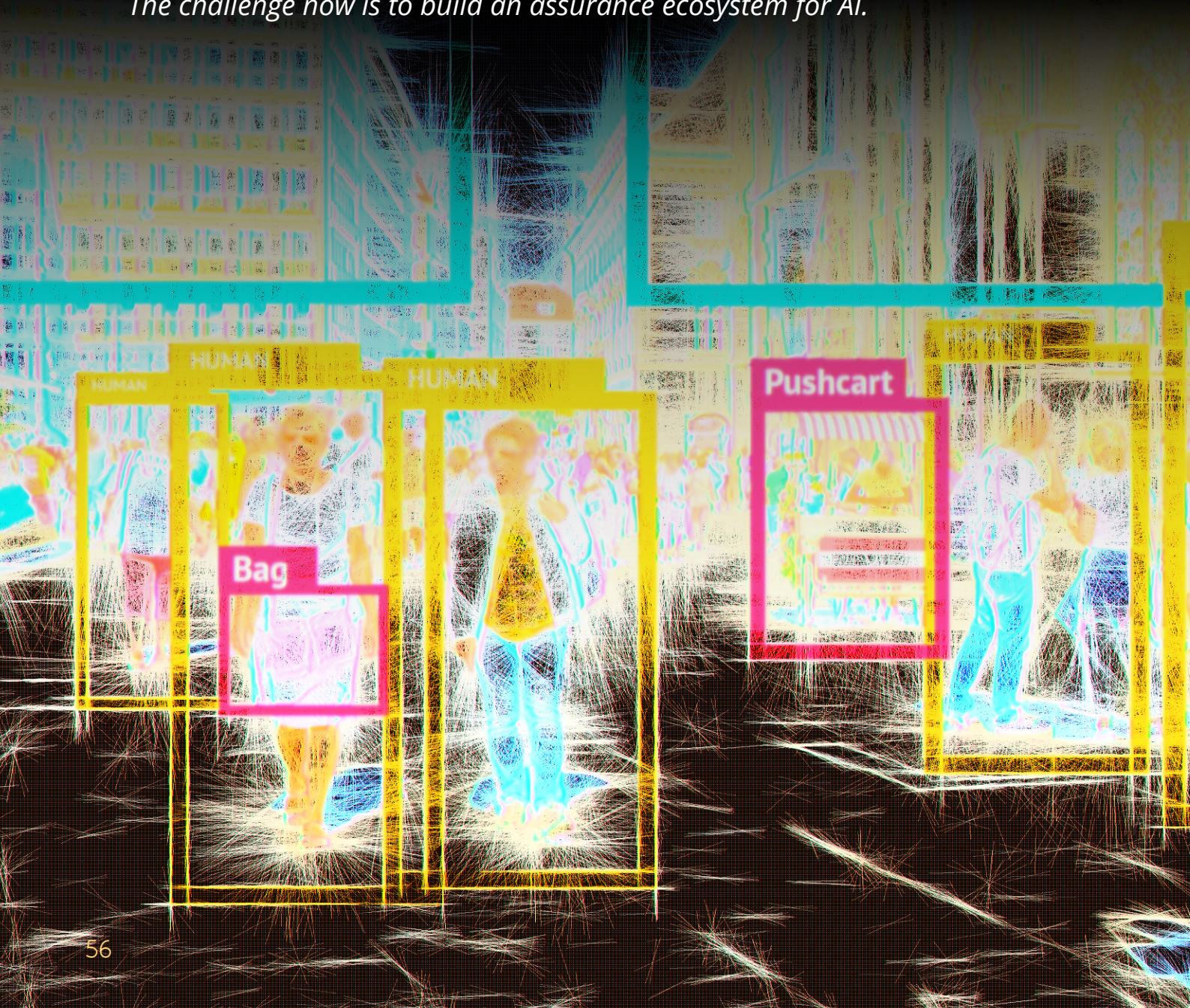
The ICO will take the research findings into account in our future work on AI and in our production of further guidance on this and other related topics.

Read **Explaining decisions made with Artificial Intelligence** at ico.org.uk

[15] Mike Bamford and Michael Worledge (2019). *Information Rights Strategic Plan: Trust and Confidence*. ICO and Harris Interactive.

Enabling trustworthy innovation by assuring AI

In other sectors, mature ecosystems of assurance products and services enable people to understand whether systems are trustworthy. The challenge now is to build an assurance ecosystem for AI.

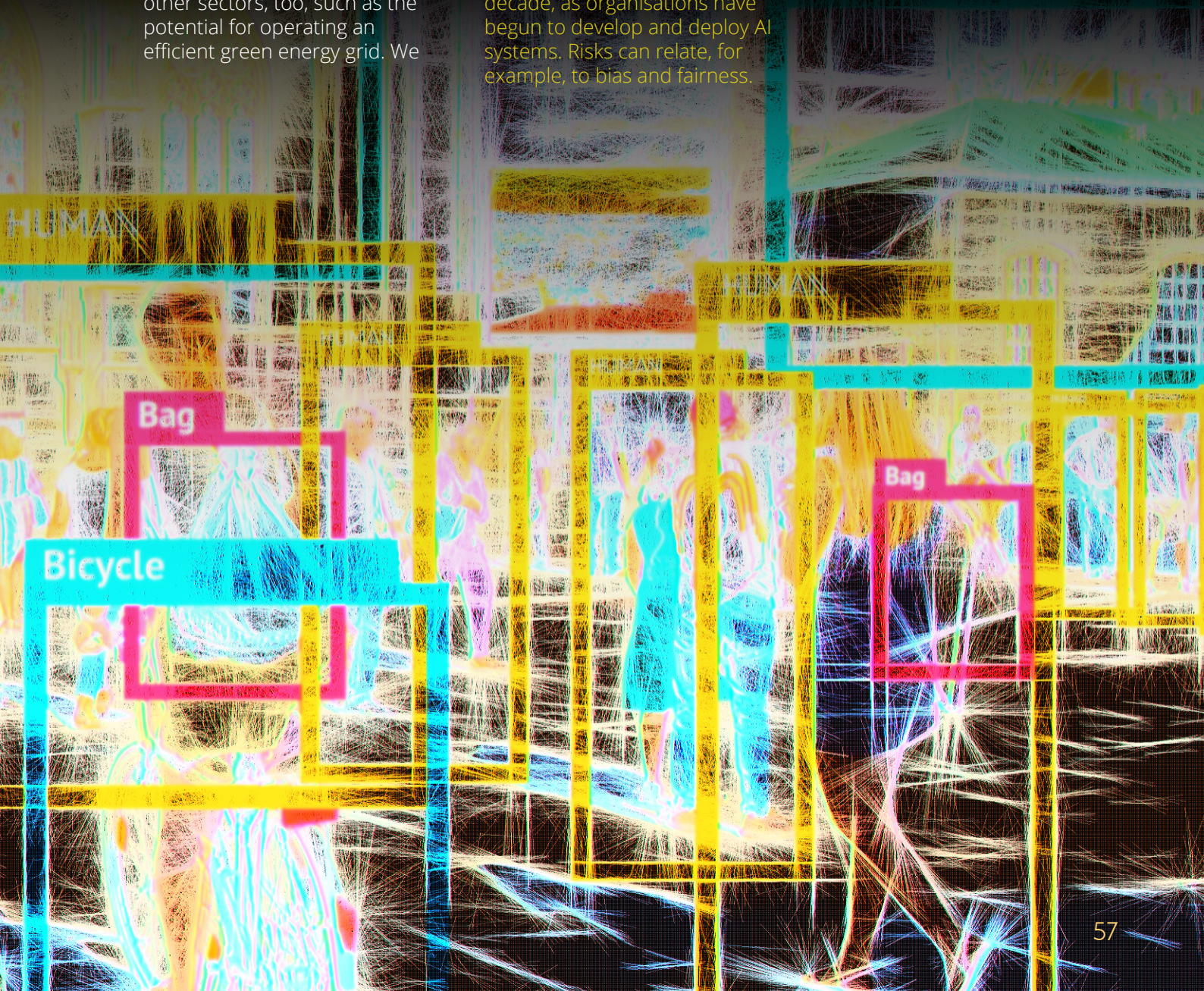


AI offers huge potential to transform our society and economy. It has been harnessed to combat the pandemic; from supporting the discovery of new vaccines and rapid virus detection methods, to powering dashboards that help clinicians make treatment decisions on the frontline.

In 2020, DeepMind's AI system AlphaFold made a huge leap forward in solving one of biology's greatest challenges, the protein folding problem, which could vastly accelerate efforts to understand the building blocks of cells, in turn improving and speeding up drug discovery. AI presents game changing opportunities in other sectors, too, such as the potential for operating an efficient green energy grid. We already feel the benefits of AI in our daily lives; it powers smart speakers and increasingly accurate real-time translation, as well as recommendation systems, which tell us which show or song we might enjoy next.

There are risks that need to be managed if we are to seize the benefits of AI

However, there are a range of risks associated with AI that need to be managed. These risks often go beyond the challenges posed by regular software because of AI's autonomous, complex and scalable nature. There have been several examples of these risks materialising in the past decade, as organisations have begun to develop and deploy AI systems. Risks can relate, for example, to bias and fairness. For instance, AI recruitment tools have been found to favour men due to biases in the data they were trained on. They can also relate to accuracy. For example, AI systems used in healthcare have given unsafe and incorrect treatment recommendations. Risks can also arise that are to do with robustness. Autonomous vehicles' computer vision systems have been found, for example, to struggle with a variety of sub-optimal conditions on the road, such as low light and partially obscured road signs, which can cause accidents. Challenges such as these make organisations more uncertain about adopting AI, and people more wary of trusting automated decisions. »



We can learn from the success of other sectors in managing risk

The good news is that these challenges are not without precedent. Throughout the 20th century, industries developed a range of processes to manage risk and drive trustworthy adoption of their products and services. In finance, audit became widespread as a means to demonstrate the accuracy of a company's financial statements. In the food industry, safety and nutrition standards ensure that consumers can purchase food in the supermarket, secure in the knowledge that it's safe to eat. In technologically complex industries, such as medical technology and aviation, quality assurance throughout the supply chain prevents accidents which could have fatal consequences.

The challenge now is to build an assurance ecosystem for AI

We now need to build an effective assurance ecosystem for AI. This has the potential to unlock benefits for our society and economy, as it has in other sectors. An assurance ecosystem for AI will enable those involved in the development and deployment of AI to assess the trustworthiness of AI systems, and communicate this information to others. For instance, it will enable developers of AI systems to assure others in the supply chain, such as an organisation procuring AI, that the AI systems they have built are trustworthy and legally compliant. Meanwhile, it will enable those deploying AI to communicate this information to those affected by AI systems, such as a job applicant whose CV is sifted using an AI tool. In doing so, assurance will help to build public trust in data-driven technologies, and will make organisations more willing to invest in AI.

Companies are beginning to offer AI assurance products and services, both in the UK and internationally. However, efforts are currently fragmented, and there have been several calls for better coordination, including from the Committee on Standards in Public Life.

The CDEI's roadmap will help to catalyse the development of an effective AI assurance ecosystem

To address this, the Centre for Data Ethics and Innovation (CDEI) will soon publish an AI assurance roadmap, which is the first of its kind. It will set out the steps required to develop a mature AI assurance ecosystem. It identifies areas for action, such as the need to develop commonly accepted standards, and shape a diverse market of assurance providers to overcome skills gaps. To develop the roadmap, the CDEI has engaged widely, conducted multidisciplinary research, and worked with partners in the public, private sector and academia to run pilot projects.

AI assurance will become a significant economic activity in its own right

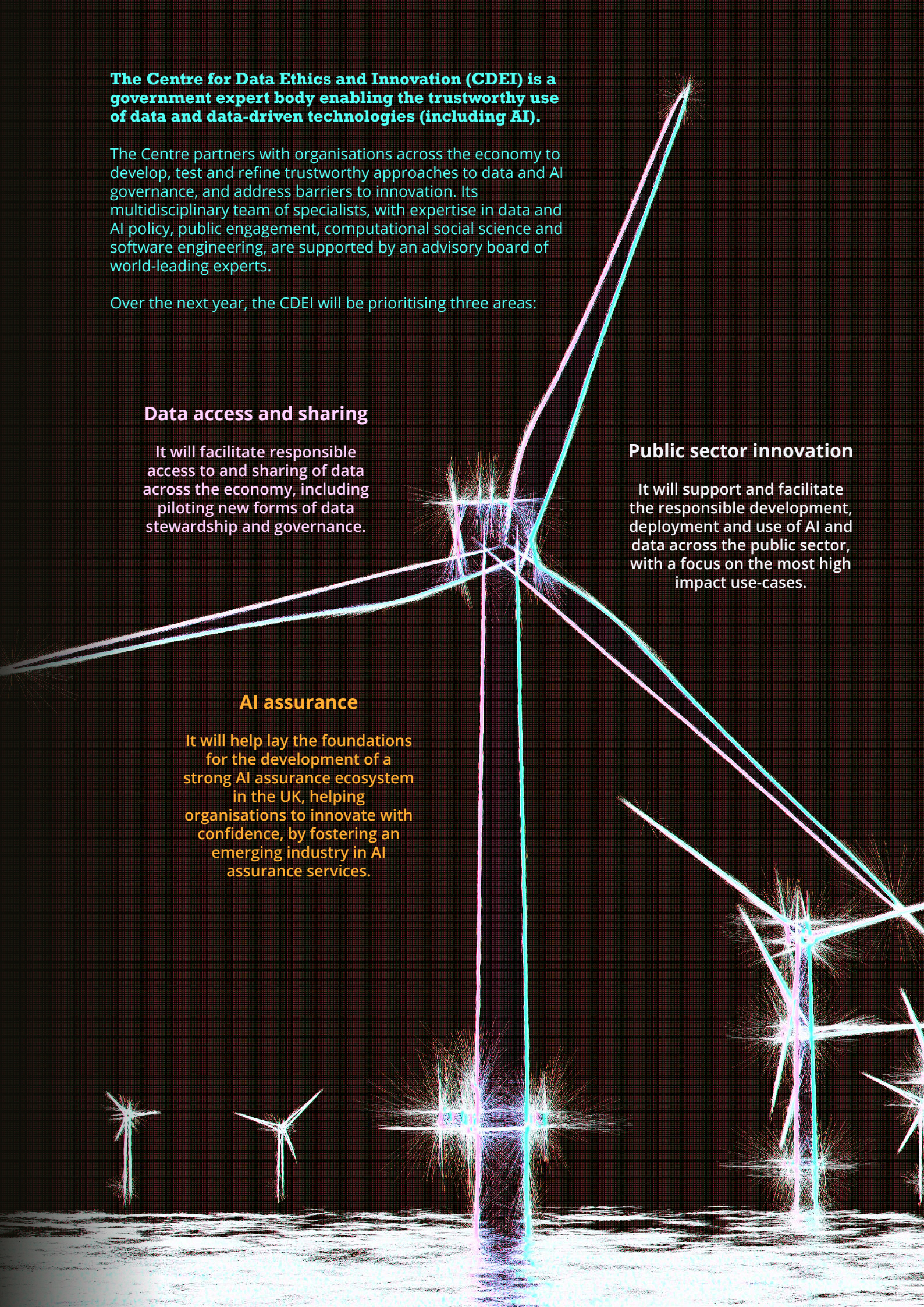
There is a huge opportunity here: not only will an effective AI assurance ecosystem enable the trustworthy adoption of AI, but it also represents a new professional services industry in its own right, and is an area in which the UK, with particular strengths in legal and professional services, has the potential to excel in. According to DCMS, the UK's cyber security industry, which is an example of a mature assurance ecosystem, employed 43,000 full-time workers in 2019, and contributed nearly £4 billion to the UK economy. As the use of AI systems proliferates across the economy, an AI assurance industry will unlock growth and thousands of new job opportunities in a similar way.

We have a window of opportunity to shape how this market emerges. Getting this right will require an active and coordinated effort from government, industry, developers, standards bodies and regulators. If you are interested in exploring opportunities to partner with the CDEI to build an effective AI assurance ecosystem, please get in touch at ai.assurance@cdei.gov.uk.

The Centre for Data Ethics and Innovation (CDEI) is a government expert body enabling the trustworthy use of data and data-driven technologies (including AI).

The Centre partners with organisations across the economy to develop, test and refine trustworthy approaches to data and AI governance, and address barriers to innovation. Its multidisciplinary team of specialists, with expertise in data and AI policy, public engagement, computational social science and software engineering, are supported by an advisory board of world-leading experts.

Over the next year, the CDEI will be prioritising three areas:



Data access and sharing

It will facilitate responsible access to and sharing of data across the economy, including piloting new forms of data stewardship and governance.

Public sector innovation

It will support and facilitate the responsible development, deployment and use of AI and data across the public sector, with a focus on the most high impact use-cases.

AI assurance

It will help lay the foundations for the development of a strong AI assurance ecosystem in the UK, helping organisations to innovate with confidence, by fostering an emerging industry in AI assurance services.

The UK is considered one of the b
To keep it that way we are looking ahe

AN IP SYSTEM WH

The UK's IP system is considered one of the best in the world – and we want to keep it this way.

To be the strongest catalyst for innovation, our IP system must meet the challenges of today, while embracing the opportunities of the future. The emergence and continued growth of AI is one of the clearest examples of both.

That technology that human innovation has created has evolved. The technology can now act as an innovator. What would once would have been considered science-fiction is becoming everyday reality: from vehicles that can drive themselves to neural networks that can help restore creations made some 400 years ago, resurrecting the genius of a Dutch master. It is worth reflecting that in Rembrandt's day, concepts that now feel simplistic, such as a calculator or a TV remote, would have been almost impossible to describe, and may simply have been condemned as the work of 'black magic'.

Strikingly, many of the new technologies we now take for granted in our everyday lives simply could not have been imagined – at least, beyond the realms of fantasy – just 30 or 40 years ago. Many of us, growing up, would not have expected to one day capture an instant photograph of our takeaway supper (perhaps ordered by yelling at a smart speaker in our kitchen), and share this with a global audience in less than a second! With the pace of change inexorably increasing, to imagine what may await just ten years ahead can leave us feeling slightly in awe.

Whatever change may look like, it is increasingly clear that the role of AI will only become more prominent.

As part of our ambition to be the best IP office in the world, the IPO is, itself, on a journey of transformation. An essential part of this is seizing the opportunity of AI to improve our services.

We've introduced an AI based pre-apply service for trade marks. Utilising machine learning in combination with features like Optical Character Recognition, this service is already attracting hundreds of users a day, and excellent feedback.

We're also researching how AI could assist with carrying out prior art searches, and we're working with the European Patent Office on the

est IP environments in the world. ead to the challenges that AI will bring.

ERE AI CAN THRIVE

Tim Moss
CEO,
Intellectual Property Office

development of their next generation search tool, which incorporates a semantic search engine. And to provide an even better experience for our customers, we're also developing AI-based tools that will help streamline our internal processes, making them more efficient. This is a taster of what's more to come as we transform our services for the digital age.

Our IP system must remain fit to thrive on the challenges of such rapid – and yes, potentially volatile – change. It cannot afford to remain static.

And so last year we led a call for views about the future impact of AI on patents, copyright, trade marks, designs and trade secrets. The role and significance of AI – compared to humans – in the innovation process generated significant debate. Many felt that the 'human' inventorship requirements could be barrier to innovation increases. Others argued that IP protections for AI creations and inventions were unnecessary, as machines cannot be incentivised.

In late 2021, we will consult on possible changes to patent and copyright law, and will ask some big questions. Should patents and copyrights protect things made by AI? And how can we improve the way AI might use material protected by copyright to support innovation and research?

An accessible, efficient and balanced IP system has the power to unleash innovation's potential. It will help ensure the UK is the best place in the world for technology leaders to flourish, foster the best environment for AI start-ups and scaleups, and make the UK the natural home for ground breaking R&D.

We share an ambition to make Global Britain a science super-power, and the most attractive place in the world for innovation to call home.

Your views will inform the discussions that will shape our future – it is vital that we hear them. Through engagement, dialogue and appreciation of the large-scale challenges we share, our shared ambition can become a reality – **with a world-leading IP system at its core**.

Read the Government response to call for views on AI and IP at **gov.uk/ipo**

On the eve of the National AI Strategy launch we met with Chair of the AI Council Tabitha Goldstaub to discuss how the Council worked together and with the wider AI ecosystem to develop the ideas and recommendations described in the AI Roadmap.

A route to becoming a science superpower...

...the AI Roadmap

Earlier this year the AI Council published its 'AI Roadmap'. Tell us how this came about?

It was June 2020 and governments around the world were scrambling to respond to the challenges of COVID-19. The AI Council had switched its focus to aiding the immediate crisis response – connecting up different parts of the AI ecosystem to support the government and making sure the needs of the AI community were properly reflected in the various support packages that followed. When the urgent work subsided, the Council felt a growing need to articulate how AI could aid the UK's recovery from the pandemic and increase our preparedness for future emergencies. So, we set about writing a collective vision for how AI policy should develop in the UK over the coming decades. We called the resulting document our 'AI Roadmap'.

What are the key messages of the AI Roadmap?

It's important to say at the outset that our Roadmap is not a strategy, nor is it an instruction manual. Instead it sets out a series of signposts and a strategic direction of travel for the government to consider as it develops its own policies.

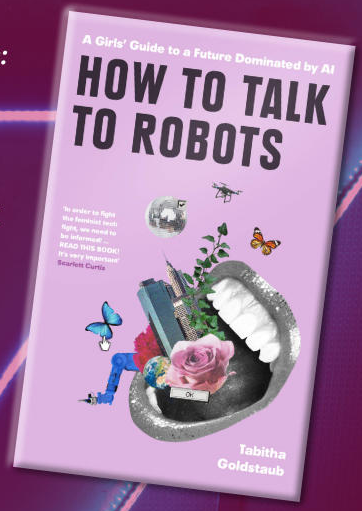
The Roadmap has two underlying messages: first, that the UK starts from a position of strength in the fundamental enablers of AI development - R&D, skills, infrastructure, and so on - and we must 'double down' on the investment in the areas where intervention has been successful. And second, we must be ready to adapt to the coming disruptions of the next 5 to 50 years. This means keeping track of the emerging applications for AI, planning for the long-term and tackling the ethical and social considerations head-on.

We recommended the government write its own National AI Strategy to catalyse and support the development of AI for the UK economy and society to flourish.

In total we made sixteen recommendations for the government to consider in this suggested strategy. These ranged from scaling up public sector investment in fundamental AI research to committing to a 10-year programme of AI skills-building to achieve AI and data literacy for everyone.

What inspired your recent book *'How to Talk to Robots: A Girls' Guide to a Future Dominated by AI'*

The book was born out of a talk I gave in 2018 to women working in creative industries. I looked around the room and realised I couldn't give my usual speech. These women were at the top of their respective fields... and yet many still weren't aware of the power of AI or its impact on their industries and livelihoods. So I issued a call for women to embrace the changes coming down the tracks and ensure that AI works for them... *not* the other way around! Unbeknown to me there was a publisher sitting in the audience who loved my rallying cry and suggested I turn it into a book.



What are your hopes for the future development of AI?

AI has the potential to become an engine for scientific discovery across disciplines – from predicting the impact of climate change, to using genetic data to create new healthcare treatments, and from finding new astronomical phenomena to identifying new materials here on Earth. What excites me the most is the growing trend for collaboration and openness in the development of AI. This approach will both enable a proliferation of additional breakthroughs but also, hopefully, encourage more trustworthy research and companies which in turn, inspire more trust in the systems which our world is being built on. DeepMind's open-sourced AlphaFold's code and AlphaFold Protein Structure Database is a good example of this trend. In the hands of scientists around the world, this new protein almanac will open new research horizons, enabling and accelerating research that will advance our understanding of these building blocks of life. »

Tell us about your other priorities as Chair of the AI Council?

I'm passionate about increasing the diversity of people working on and with AI. Ultimately, we need AI communities to reflect the society they inhabit. Only then will we get the widest and most innovative range of future technologies. As my fellow Council member Dame Wendy Hall is fond of saying: *"if it's not diverse, it's not ethical"*. So I spend a lot of my time making sure that diversity is front and centre of decision makers' minds. There are some wonderful examples of positive action. For example, the conversion courses in data science and AI funded by DCMS have been enormously successful at attracting those from underrepresented groups to explore the field of AI.

> *"We must be ready to adapt to the coming disruptions of the next 5 to 50 years. This means keeping track of the emerging applications for AI, planning for the long-term and tackling the ethical and social considerations head-on."*

How has the Council supported the development of the AI Strategy?

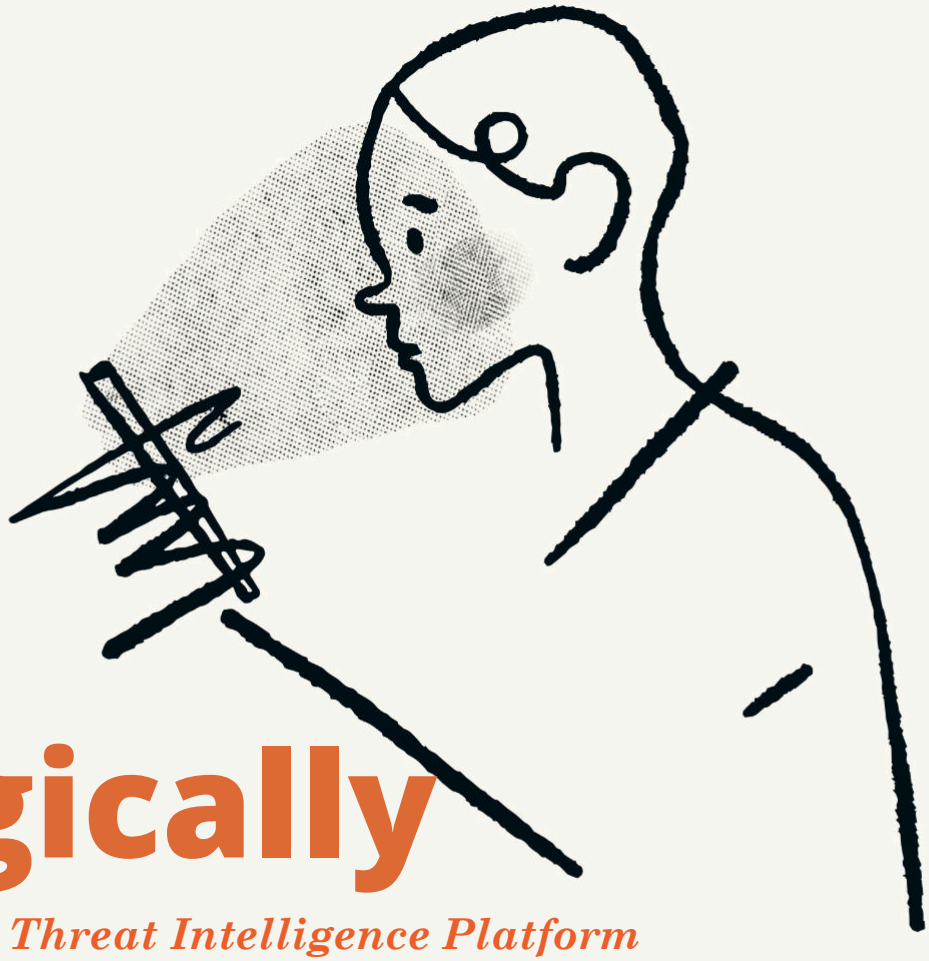
Once the Secretaries of State committed the Office for AI to writing a strategy we hosted a series of twelve themed roundtable discussions covering everything from the needs of start-ups and barriers to industry adoption, to the future of research and innovation; and the importance of building trustworthy AI systems. As well as dedicated sessions focused on Scotland, Wales and Northern Ireland to make sure voices across the UK were heard.

These roundtables gave us a great insight into the challenges and opportunities ahead but in order to truly get a feel for what excited and concerned the ecosystem we realised we needed to take a read from more people. **With support from The Alan Turing Institute we carried out an online survey of the wider AI community. We were delighted to receive over 400 responses from those researching, developing, working with and using AI technologies.** Our hope is that the results will help the government to prioritise its investments as it sets out to cement the UK's place as a "science superpower".

> *"There are some wonderful examples of positive action. For example, the conversion courses in data science and AI funded by DCMS have been enormously successful at attracting those from underrepresented groups to explore the field of AI."*

Lastly, if you could choose one superhero power what would it be, and why?

Joy! I'd like the ability to help people find happiness at the wave of a hand. I'm not sure if I need to explain why! I believe happy people are kind people and kindness could close the gap between those that have the most and those that have the least and we all know that would solve the world's problems.



Logically

All-In-One Threat Intelligence Platform

Logically combines advanced AI with one of the world's largest dedicated fact-checking teams to help governments, businesses and the public uncover and address harmful misinformation and deliberate disinformation that is increasingly spread across the world. Based in Brighouse, West Yorkshire, the team has a mission to bring credibility and confidence to news and social discourse globally, aiming to restore trust in a fractured media landscape.

What piece of advice would Logically give to a founder who's thinking about joining Applied AI?

Absolutely do it! We found it incredibly useful being able to discuss both with peers and alumni companies some of the challenges we've faced, and equally valuable hearing about their own experiences growing a business.

How does Logically use AI to combat disinformation?

We've developed a suite of different AI-powered tools. Earlier this year, we launched a new threat intelligence platform, Logically Intelligence which can detect and flag harmful or misleading narratives, as well as identify the demographics that are being targeted. It's a particularly useful tool because it integrates these analytical capabilities with effective countermeasures - so we can actually take swift action against harmful or coordinated activity.

Our use of AI and cloud infrastructure is crucial for tackling content at scale and at pace, but we also complement our tech with human analysts, who can identify complex trends and continuously test and improve our AI tools. We believe that this combined approach is the best way to effectively tackle misleading content at the moment.

How has Logically used these tools?

During the 2020 US Presidential elections, we worked with a major battleground state to detect, analyse and combat misinformation that might threaten the election's integrity. We found false information circulating online such as long lines or COVID-19 outbreaks at voting booths, and confusion over required identification, and saw how these narratives were being used to deter and suppress voters. It was a successful project - over the course of three months, our AI ingested millions of pieces of content, identifying and analysing around 40,000 threats to election integrity and public safety which could then be acted upon.

logically.ai

CREATIVE DESTRUCTION LAB OXFORD

CUTTING EDGE

When the Creative Destruction Lab arrived in the UK, it brought something completely new and different into the innovation ecosystem. It's not an accelerator or an incubator but a mentoring programme for early-stage deeptech start-ups, where founders work consistently with a group of world class mentors.

The Creative Destruction Lab (CDL) Oxford is a non-profit nine-month programme located at the University of Oxford's Saïd Business School. Housed at one of the leading universities in the world, CDL-Oxford also leverages its close proximity to London, a global epicenter of innovation.

The CDL-Oxford runs programmes in AI and Health and has supported over 75 seed stage, science and deep-tech companies since inception two years ago.

The Lab is funded by UKRI-Research England along with Barclays, Goodwins and eight entrepreneurial Founding Partners, and is on target to create over £1 billion in equity value by the end of its fourth year.

Start-ups who join one of the programmes work closely with mentors to sharpen objectives, prioritise time and resources, raise capital, and engage with experts working on the frontiers of research.

The start-ups attend five in-person objective-setting sessions between October and June. CDL is a non-profit organisation so there are no fees for joining and CDL doesn't take any equity.

The CDL-Oxford's distinguished list of Mentors include: Patrick Pichette, Former CFO at Google and General Partner, iNovia Capital; Torsten Reil, Co-Founder and CEO of NaturalMotion; William Schnoor, Partner Goodwin Procter LLP; and William Tunstall-Pedoe, Founder of Evi (acquired by Amazon).

CDL has helped 1700+ companies globally, about a third in/with AI technologies with a combined portfolio worth £4 billion

CDL is financially supported by several private donors, Research England, The Government of Canada, Barclays, Goodwin Law Firm, and the University of Oxford

Roll Call...

20 companies from across the UK have graduated from CDL Oxford's AI programme in the last two years:

Class of 2020: Arctoris, Caristo Diagnostics, Greyparrot, iSize Technologies, Nodes & Links, nScribe, Nucleome Therapeutics, Odin Vision, Unitary and WalkOut.

Class of 2021: Hades, Deep Planet, Robin AI, Circuit Mind Limited, FLOX, Lynceus, DeepOpinion, Continuum Industries, LGN and Slingshot Simulations.

Who Should Apply?

The AI programme is suited to visionary, founders building technologies that leverage artificial intelligence, or that are solving problems that will significantly advance the field of artificial intelligence. The programme is tailored towards early-stage companies pre-seed or seed.

Interested in enrolling?

Calling all founders:
creativedestructionlab.com/streams/ai

Over 900 students participated at CDL's High School Girls Programme, aimed at inspiring the next generation of entrepreneurial science business leaders

CDL-Oxford has scaled up to offer four mentoring programmes in AI, Fintech, Climate and Health start-ups

LGBT+ hero, Alan Turing

Alan Turing, pioneer of theoretical computer science, 1912-1954

Alan Turing was born in London in 1912 just two years before the First World War. Growing up in the aftermath of brutal international conflict, Turing's parents were keen to ensure that their son was able to thrive within education.

His passion for learning became clear when at the age of 13, the 1926 General Strike prevented Alan from attending his first day of school. Determined not to miss it, Alan Turing cycled 60 miles on his bike unaccompanied, stopping overnight at an inn and attending school the next day.

It became clear from an early age that Alan Turing was a maths prodigy, and over the course of his life and career Turing pioneered mathematics and computer science, changing the way we see and understand the world. From altering the course of history by breaking the Enigma code at Bletchley Park during the Second World War, through to applying his practical war-time experiences to design the principles of which underlie modern computers, Alan Turing's legacy has shaped the lives of millions of people.

However, Alan Turing faced much hardship during his life due to his sexuality. During Turing's life, homosexuality was a criminal offence and Turing was convicted in 1952 of "Gross Indecency". Alan Turing was faced with an impossibly cruel choice of imprisonment, or probation on the condition he underwent chemical castration. Turing died from suicide two years later.

More than a century since the birth of mathematician Alan Turing, much has changed within the social, political and cultural landscape of the UK. One of the defining markers of change has been the LGBT+ liberation movement, which began in the 1970s and campaigned for equal rights for the gay community.

Thanks to the efforts of activists, historians and politicians, Turing's legacy has not been forgotten. In 2013, HM Queen Elizabeth II signed a pardon for Turing's conviction with immediate effect. Since then, the Alan Turing Law has gone on to secure pardons for 75,000 other men and women convicted of similar crimes.

ARTIFICIAL INTELLIGENCE WITHIN THE PUBLIC SECTOR

A HANDY GUIDE TO PROCUREMENT

AI has the potential to play a key role in the delivery of public services - Maija Banks, Category Manager for AI and automation, explains how Crown Commercial Service (CCS) is helping customers embrace it.

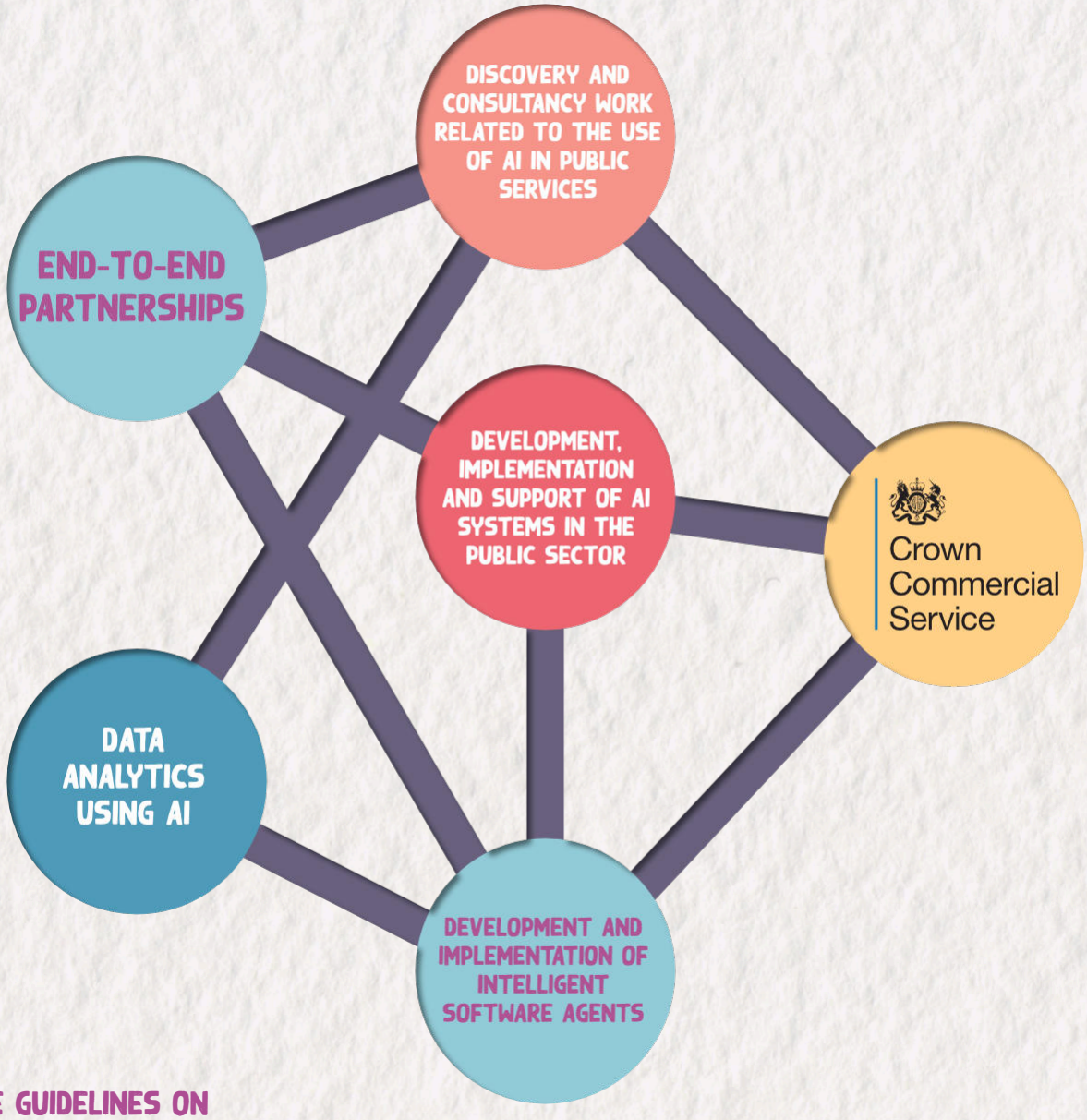
Right across the public sector, organisations are exploring how artificial intelligence solutions can help them to embrace change and future-proof the way they work.

The COVID-19 crisis has sped up the adoption of AI in the public sector. By pushing processes, people and services online, it has forced local, regional and national governments to lead by example. The future productivity of the public sector relies on its readiness to adopt ethical AI and implement next-gen tech, which will be all the more important to improve citizens' lives for the better, in particular through a post-pandemic economy.

AI can help the public sector to manage and use data better, and make public services more accessible. Applied correctly, it can deliver better outcomes for society at large. For example, across government departments intelligent automation tools are now performing repetitive tasks, freeing up time for operation managers and case workers to spend on more valuable work; chatbots are allowing citizens to speedily access information and services from local authorities; and new innovative AI intervention tools are being deployed to help High Street footfall reach pre-pandemic levels.

With the use of AI in the delivery of public services only likely to grow in the coming years, CCS continues to offer potential public sector buyers' access to these cutting-edge technologies, along with support from industry experts, giving them the power to transform their digital services as we build back better.

47% OF THE SUPPLIERS APPOINTED TO THE AI DPS ARE SMEs



THE GUIDELINES ON AI PROCUREMENT

The guidelines, developed in collaboration with the World Economic Forum Centre for the Fourth Industrial Revolution, are intended to advise public sector buyers of AI solutions on the guiding principles of AI procurement. They focus mainly on machine learning as a subset of AI, and advise on strategy, decision making, data, benefits and risks, effective market engagement, routes to market, governance, lifecycle management, and the all-important question of ethics.

Throughout the guidelines, messages are repeated that should apply to all procurements - that you should start from a problem, rather than a solution, that it is the people of your organisation who will in the end be responsible for the success or otherwise of your eventual product or service, and that you must, where possible, plan for an end-to-end lifecycle.

The guidelines, it is hoped, will eventually drive the responsible adoption of AI across all sectors of the UK economy, with the public sector leading the way. That is crucial in a sector where standards and regulations are often playing catch up with technology. »

THE GUIDELINES FOR AI PROCUREMENT HELPED SHAPE THE CROWN COMMERCIAL SERVICE'S AI DPS, WHICH WILL ADDRESS ETHICAL CONSIDERATIONS WHEN ORGANISATIONS BUY ARTIFICIAL INTELLIGENCE SERVICES FOR USE IN THE PUBLIC SECTOR.

THE TOOL AIMS TO BOOST SAFE AND FAIR INNOVATION ALONGSIDE IMPROVED PUBLIC SERVICES TO PEOPLE UP AND DOWN THE COUNTRY.

THE AI DYNAMIC PURCHASING SYSTEM (DPS)

At the same time as the Guidelines on AI Procurement were being written, we were developing what would become the Artificial Intelligence DPS.

This commercial agreement is the UK Government's first attempt to design a framework (technically a Dynamic Purchasing System) for best practice in AI procurement in the public sector

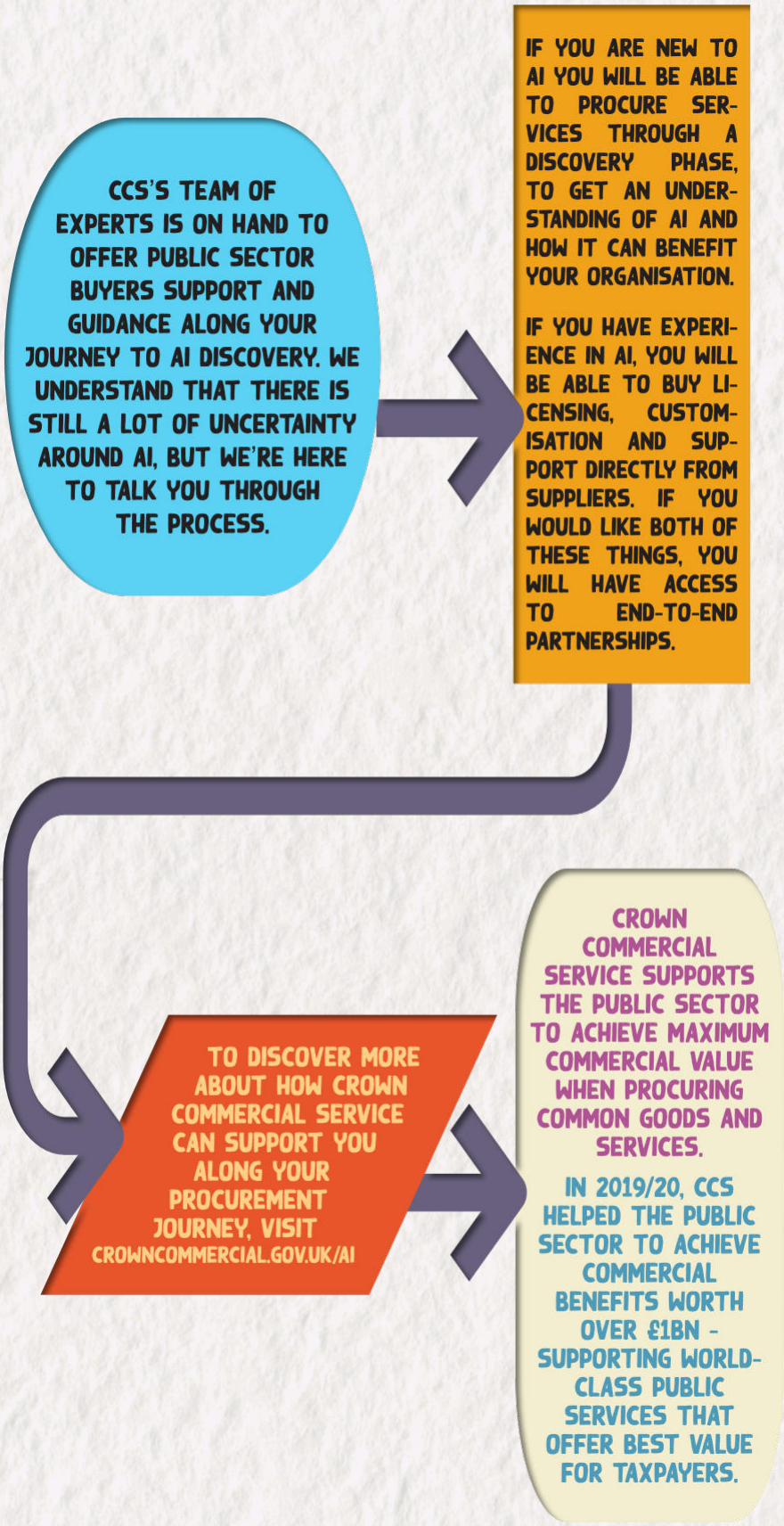
Public sector customers will be able to use the agreement to access the latest in Artificial Intelligence services including business analysis, software development and implementation, and data analytics. The scope of the DPS offers access to technology for medical screening and diagnosis, chatbots to drive up the quality of customer experience, and virtual assistants.

Suppliers can join throughout the duration of the agreement, creating a wide range of competition in an emerging market. Barriers to entry have been removed making it easier for smaller

businesses to become suppliers and it is anticipated that 35% of suppliers on the agreement will be SMEs.

The agreement gives buyers the opportunity to work with suppliers of AI solutions within the guidelines set out by the government - requirements which will develop and grow as the technology does the same. Launched in September 2020, there has already been encouraging uptake of the agreement among the health sector and local government.

All suppliers on the agreement need to identify ethical considerations in relation to data limitations, fairness and bias. In line with the guidelines, they need to demonstrate how the skills, qualifications and diversity of teams developing and deploying AI have been considered, and ensure the outputs of the AI technology are transparent and explainable to a non-expert audience. They also need to be able to describe how data will be protected and set out the level of human decision-making at critical points.



The word algorithm derives from Muhammad ibn Mūsā al-Khwārizmī, latinised as Algorithmi, a Persian polymath who produced vastly influential works in mathematics, astronomy, and geography.

A is for algorithm

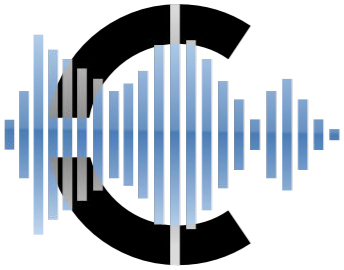
A sequence of rules that a computer uses to complete a task. Algorithms underpin the technology that makes our lives tick, from smartphones and social media to sat nav and online dating. They're also used to make predictions in health, insurance, law and more.

B is for big data

A field of research that deals with large, complex datasets. The field has grown rapidly over the past couple of decades as computer systems became capable of storing and analysing the vast amounts of data being collected about our lives and our planet.

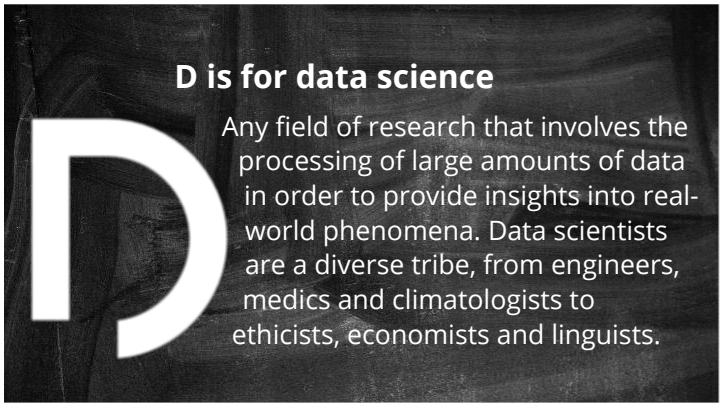
A IS FOR ALGORITHM

There is a lot of jargon in data science and AI. Thankfully, the folks at The Alan Turing Institute have put together an A-Z of key names and terms (plus a few pop culture references), with the aim of demystifying some of the lingo.



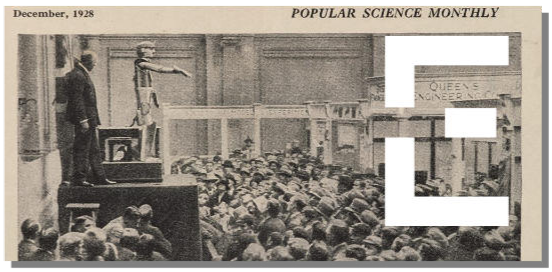
C is for chatbot

A software application that's been designed to mimic human conversation, allowing it to talk to users via text or speech. Chatbots are mostly used as virtual assistants in customer service, but there are also chatbot therapists and even chatbot politicians.



D is for data science

Any field of research that involves the processing of large amounts of data in order to provide insights into real-world phenomena. Data scientists are a diverse tribe, from engineers, medics and climatologists to ethicists, economists and linguists.



E is for Eric

Eric was Britain's first robot – a moving, talking man of steel who opened the Society of Model Engineers' annual exhibition in 1928. Some time later, Eric mysteriously disappeared, but he was rebuilt for an exhibition at London's Science Museum in 2017.

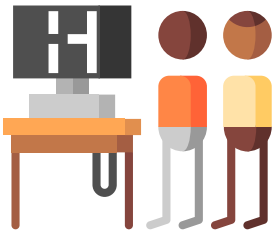
F is for fakes

Deepfakes are synthetic videos, images or audio in which someone is digitally altered so that they look, sound or act like someone else. Created by complex algorithms, deepfakes have raised concerns over their ability to spread misinformation.

G is for generative adversarial network

Photo credit: Samsung UK

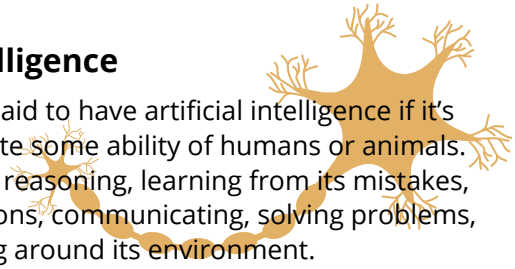
An AI technique that uses two competing computer systems to generate fake data that matches the real data as closely as possible. It can be used to create hyper-realistic deepfake photographs of people or animals who don't actually exist.



H is for human-in-the-loop

An AI system in which humans can intervene by training, tuning and testing the algorithm so that it produces more accurate results. It is a way of combining human and machine intelligence, helping to make up for the shortcomings of both.

I is for intelligence



A machine is said to have artificial intelligence if it's able to replicate some ability of humans or animals. That might be reasoning, learning from its mistakes, making decisions, communicating, solving problems, and/or moving around its environment.

J is for Julia

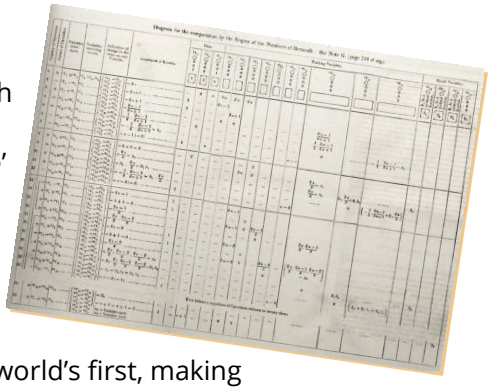
A modern programming language (launched in 2012) that is gaining in popularity among the AI and data science community because of its high speed, ease of use and flexibility. It is used in applications including climate modelling, robotics and cellular biology.

K is for Kasparov

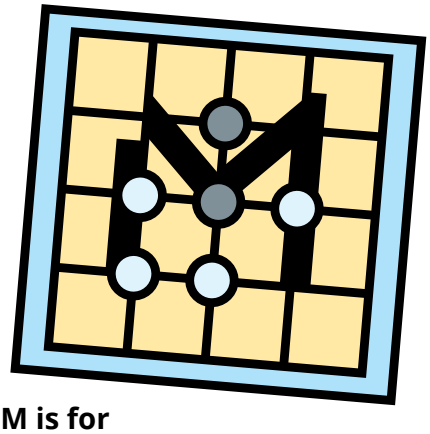
In 1997, Garry Kasparov became the first reigning world chess champion to lose a match to a computer under regular time controls. His nemesis was Deep Blue – a computer developed by IBM that could explore 200 million moves per second.

L is for Lovelace

19th Century mathematician Ada Lovelace worked with Charles Babbage on his 'Analytical Engine' mechanical computer. It was never built, but she wrote a computer algorithm for it that many regard as the world's first, making her one of the first programmers.



Above Ada Lovelace's diagram from Note G, the first published computer algorithm.

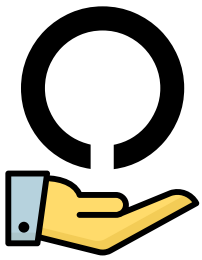


M is for machine learning

The study of algorithms that are able to 'learn' by finding patterns in sample data. The algorithms then use these findings to make decisions or predictions about new data, such as identifying tumours in medical scans or guiding a robot in a new setting.

N is for neural network

An AI system inspired by the biological brain, consisting of a large set of simple, interconnected computational units, with data passing between them as between neurons in the brain. Neural network are used in complex tasks such as image and speech recognition.



O is for open source

Software and data that is free to edit and share. It helps researchers to collaborate, as they can edit the resource and add new features that others in the community can benefit from. Any bugs in the software can also be speedily spotted and fixed.

P is for phishing

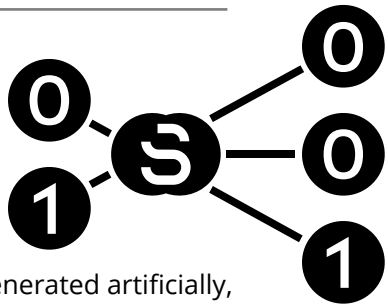
A type of cyberattack which aims to obtain information from the victim by impersonating a trustworthy company or person. AI is increasingly being used to spot phishing attempts by analysing the messages' context and content, and the sender's online behaviour.

Q is for quantum computer

AI research of the future will likely be carried out on a new generation of computers. Based on the mind-bending principles of quantum mechanics, quantum computers will process algorithms many, many times quicker than their classical counterparts.
Check out *Quantum Ready* on page 130

R is for Rossum's Universal Robots

This 1920 sci-fi play by the Czech writer Karel Čapek introduced the word 'robot' to the English language. It tells the story of a race of artificial people who rise up against their human creators and end up ruling the Earth.

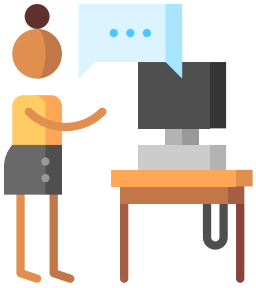


S is for synthetic data

Data that is generated artificially, rather than by real events. It retains the original data's statistical properties, but has no identifiable information, making it useful for research in areas where privacy is key, such as healthcare and finance.

T is for Turing test

A test for machine intelligence. Invented by Alan Turing, it involves a human asking questions to another human and a machine. If the human question asker cannot tell from the written responses which is the machine, then the machine has passed the test.



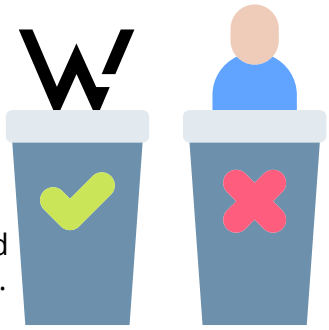
U is for uncanny valley

The unsettling feeling that many people experience around human-like robots. There are a few theories for this 'psychological discomfort', but it could be due to the brain being fed conflicting information about whether or not the robot is a 'real' person.

V is for velocity

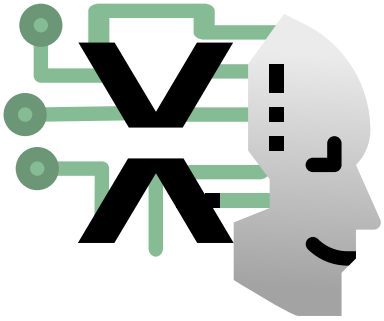
One of the 'four Vs' that characterise big data, along with volume, variety and veracity. Velocity is the speed of data generation, volume is the size of the dataset, variety is the breadth of data sources, and veracity is the quality of the data.

W is for Watson



IBM's Watson computer can analyse and respond to human questions.

In 2011, it won the US game show Jeopardy!, beating two humans to take home the $1 million top prize. "I for one welcome our new computer overlords," remarked one of the losing contestants.



X is for Ex Machina

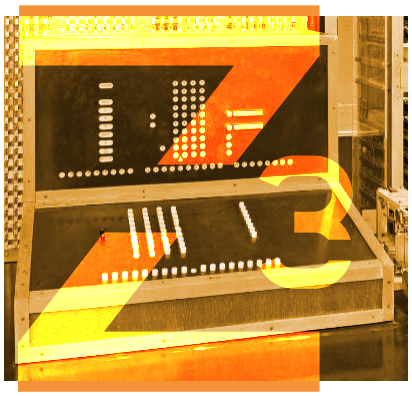
Alex Garland's 2014 film sees a programmer being asked to carry out the Turing test on a humanoid and (you've guessed it) falling in love. It won an Oscar for Best Visual Effects, and received praise for its nuanced exploration of consciousness and AI.

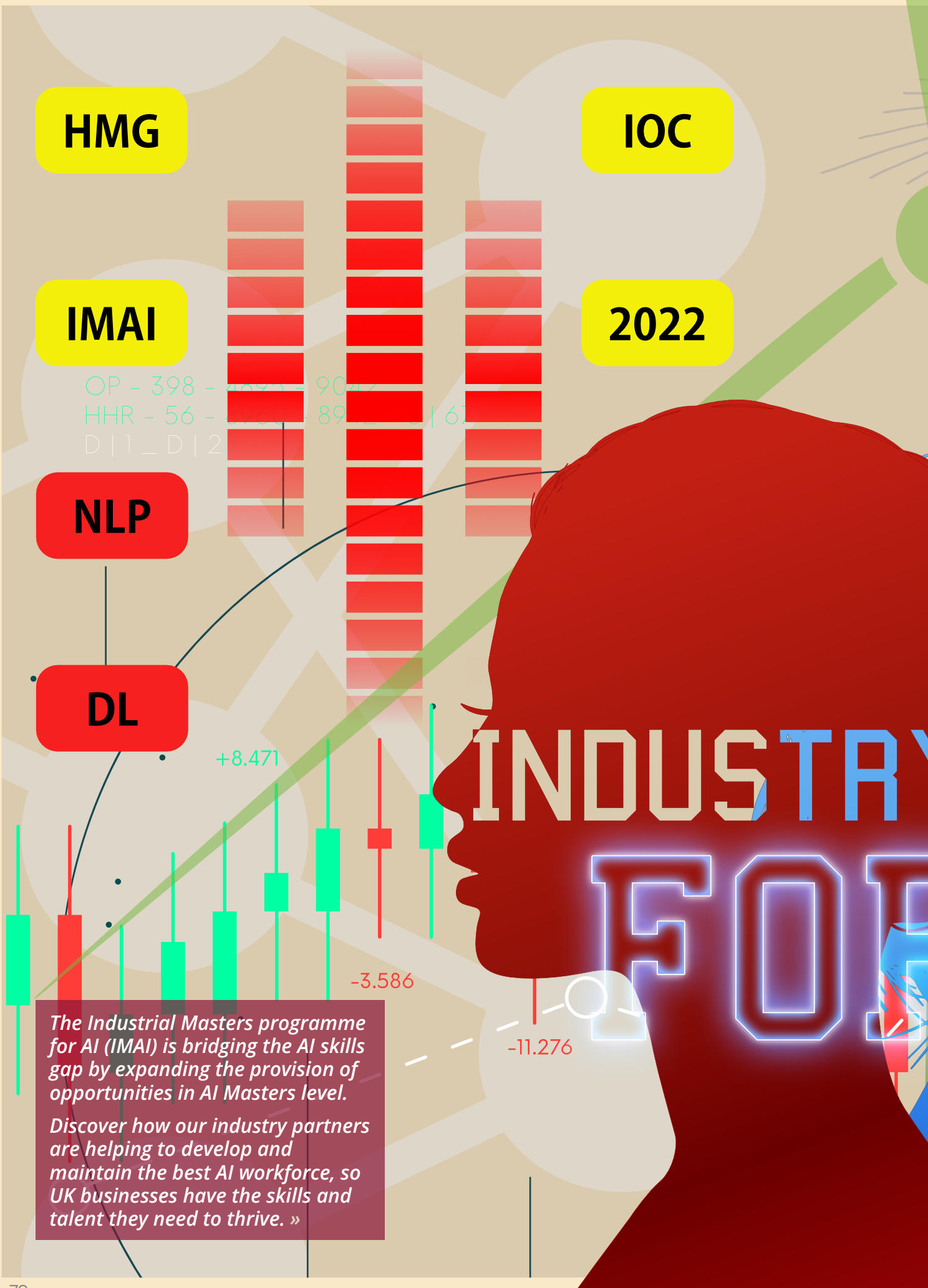
Y is for why?

Why carry out data science and AI research? We believe it can offer huge benefits to society. Tackling climate change, curing diseases, exploring outer space... all of these rely on insights from the latest algorithms, computer models and data science techniques.

Z is for Zuse

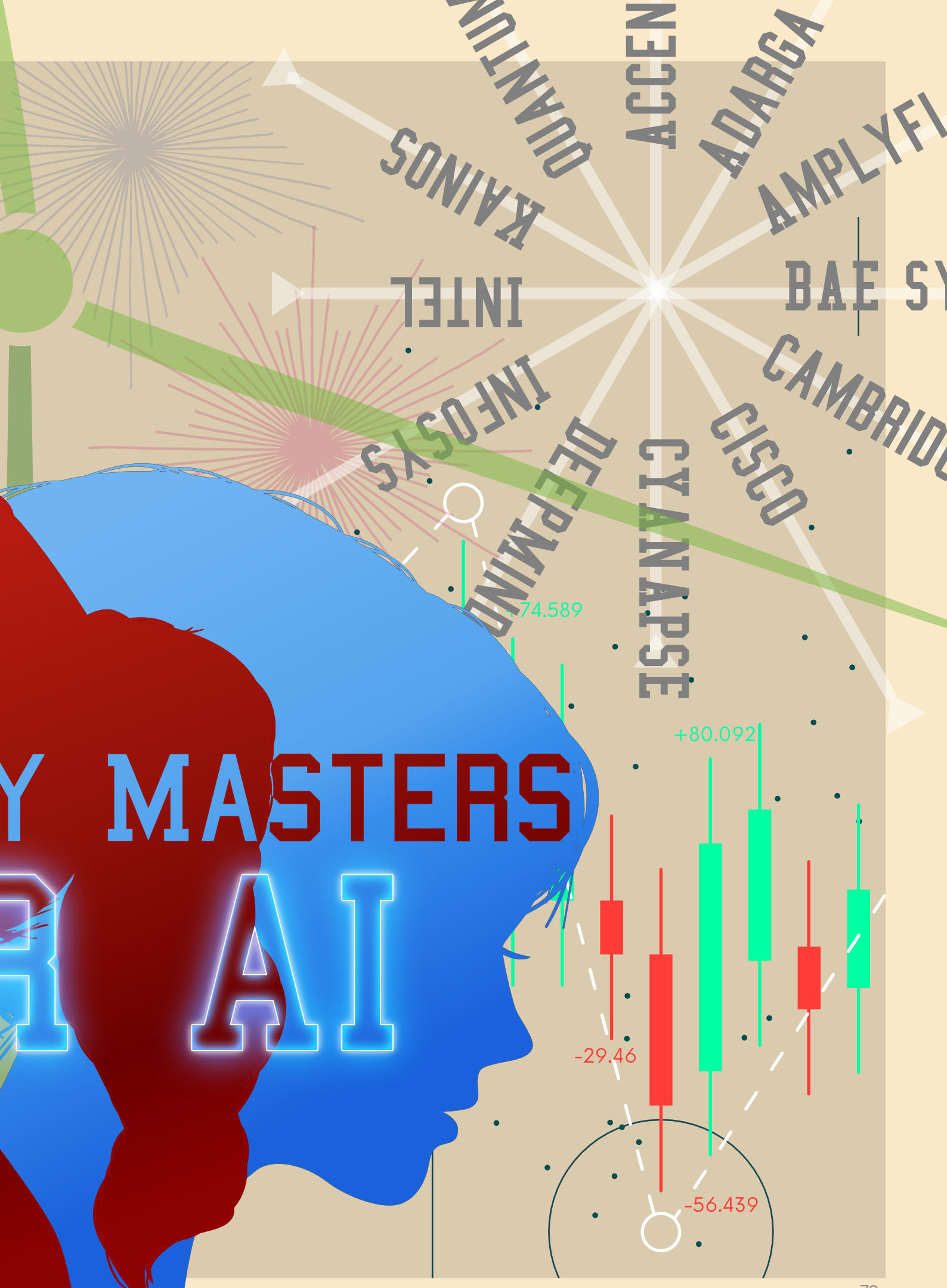
In 1941, Konrad Zuse, a German scientist and engineer, completed the Z3 – the world's first fully automatic, digital computer, which read its programs off punched film. It was destroyed during bombing in Berlin, but a replica is on show at the Deutsches Museum.





The Industrial Masters programme for AI (IMAI) is bridging the AI skills gap by expanding the provision of opportunities in AI Masters level.

Discover how our industry partners are helping to develop and maintain the best AI workforce, so UK businesses have the skills and talent they need to thrive. »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REACH INTO THE ACADEMIC AI COMMUNITY TO ACCELERATE YOUR WORK

DANIEL CLARKE, HEAD OF APPLIED SCIENCE, ADARGA - "The UK is one of the world's thought leaders in the field of AI which ultimately lays the foundation for a powerful ecosystem driving the UK technology sector. This excellent foundation is influenced by a number of factors, one of the most important of which is diversity within the UK academic community. The social and technological diversity delivered by UK Universities is hugely important, with different institutions focusing on different applications of data science and artificial intelligence. The IMAI has been key in enabling Adarga, one of the UK's leading developers of AI software for defence and national security, to reach into that diverse academic community. It has helped us to select and engage with institutions that have the right skills and expertise to accelerate the capability of our state-of-the-art Knowledge Platform™.

"Adarga has both supported, and been supported by the IMAI in a number of ways. In the first instance, Adarga is a member of the formative stakeholder's group, helping to shape activities which enhance industry's ability to deliver cutting-edge technology. Furthermore, we have been supported by the IMAI through help in placing our sponsored subjects for Masters thesis projects, and have another placement planned for the 2021/22 academic year. Key to this final activity has been IMAI's expertise in matching the technical requirements of our project work and pairing us with universities that have the appropriate technical capability.

"In summary, the IMAI provides an effective platform for Adarga to both reach into the academic community to accelerate our own work, but also for us to contribute to, and build that community."

HELPING TO GROW A LARGER, MORE DIVERSE AND BETTER-SKILLED PIPELINE OF AI TALENT

OBUM EKEKE, LEAD, UNIVERSITY RELATIONS & EDUCATION PARTNERSHIPS, DEEPMIND - "DeepMind is a multidisciplinary team of scientists, engineers, machine learning experts and more, working together to research and build safe AI systems that learn how to solve problems and advance scientific discovery for all. AI allows us to learn, imagine, cooperate, create, communicate, and so much more. By better understanding different aspects of intelligence, we can use this knowledge as inspiration to build novel computer systems that learn to find solutions to difficult problems on their own. Ensuring that future generations of AI researchers and computer scientists are representative of the world around us is essential if research is to stay relevant and beneficial to the whole of society.

"We are supporting scholarships on Masters-level programmes, working collaboratively with industry and leading UK universities, to create more spaces for AI Masters students. The IMAI programme is helping to produce a larger, more diverse and better-skilled pipeline of talent to help address the growing AI skills gap.

"By removing some of the financial barriers that prevent people applying to postgraduate study and providing mentoring and pastoral support, we hope the DeepMind scholarship programme will help build an AI community where everyone can participate and thrive - irrespective of their backgrounds."

OUR INDUSTRY PARTNERS HAVE PROVIDED SPONSORSHIP AND/OR WORK PLACEMENTS TO 150+ AI STUDENTS ACROSS THE UK

Photo credit: Cambridge Consultants

OFFERING A CAREER PATH FOR STUDENTS TO FOLLOW THEIR PASSION IN AI

AMY STEPHENS, AI GROUP LEADER, CAMBRIDGE CONSULTANTS - "It's vital we invest in AI skills for the UK. AI technology has vast potential to benefit many areas of life and the UK is playing a leading role. It will help us build mobile networks that deliver better quality video calls, speed up research into new drugs, and reduce waste in industrial manufacturing, to name just a few examples.

"We work with ambitious leaders in some of the world's largest businesses to help them understand the potential of AI and make it a reality by building AI-powered systems. AI provides us with the tools to manipulate data in new ways and help our clients tackle increasingly complex problems.

"The IMAI programme is invaluable to Cambridge Consultants. It provides us with the AI skills we need, whilst offering a career path for students to follow their passion in AI and work on ground-breaking projects for major brands and ambitious start-ups across the world. Programmes like this are vital for keeping the UK technology industry vibrant and competitive into the future."

IMAI - now running for a third year!

Join leading companies who are helping to support new industry-funded AI Masters places at UK universities.

Contact the Institute of Coding for more information: AIMasters.IOC@bath.ac.uk

Since April 2019 the following companies have funded additional AI Masters places and/or work-based placements:

Accenture
Adarga
Aggreko
AMPLYFI
BAE Systems
Bering
Cambridge Consultants
Cisco
Cyanapse
The Data Analyst Bureau
DeepMind
Intel
Kainos
Protect Box
QuantumBlack
The Data Lab
Welsh Water
Zeg.ai

We asked DeepMind Queen Mary AI Scholars to tell us about...

the people, things and goals that inspired a passion for AI

Maryia

NLP at the London 2012 Olympics

I was an intern at an AI start-up during the London 2012 Olympics. I was a part of a team that researched the sentiment around Olympians and the commercial sponsors. This is when I first learned about natural language processing (NLP) sentiment analysis.

NLP helped me identify and extract opinions from blogs, reviews, social media, forums, and news. It predicted if an opinion was positive, negative or neutral and allowed me to analyse conversations around the Olympics in near real-time from across the world and in different languages. Something that would take years if done via traditional research.

The first time I saw a human sized robot

I went to see Robots at one of my favourite places – the awe-inspiring Science Museum. It was an exhibition that explored the history of humanoid robots and our quest to understand what it means to be human.

The exhibition did a great job explaining the many multidisciplinary areas of AI, from neuroscience to psychology, and how research into robot intelligence can help us to better understand ourselves as well as the machines we build.

I remember fondly 'ROSA the robot' because her articulated skeletons, motorised muscles and artificial tendons allowed her to mimic human movements. This technology, combined with the ability to learn to understand images, sounds and languages is going to help people with disabilities lead more fuller and active lives.

When MuZero won at everything

In 2019 DeepMind's AI programme MuZero mastered Go, chess, shogi and Atari games without needing to be told the rules. This was a game-changer! (pardon the pun).

The program did this thanks to its ability to plan winning strategies and then take the best course of action in unknown environments.

The ideas behind MuZero's powerful learning and planning AI algorithms may one day pave the way towards tackling some of the world's most pressing and fundamental scientific challenges where the "rules of the game" are not known.

My DeepMind mentor Miaosen Wang

Throughout my scholarship Miaosen inspired me to keep pushing my boundaries, keep learning and keep going when the going got tough. He was always an email away and I enjoyed learning from him, as well as picking his brains on all things AI. I encourage every student to find a mentor, the collaboration can be fun and stimulating and a mentor can help you focus on the important aspects of your course.

Reaching a net-zero economy

AI is helping scientists predict climate change impacts and providing industry with new tools to help build better systems for waste management, clean energy and carbon footprint reduction.

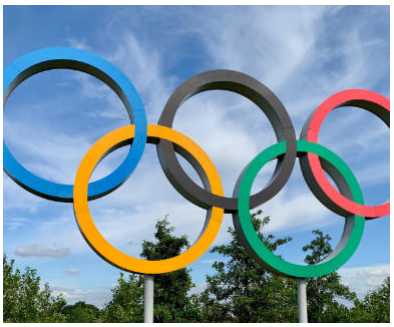
My current research is in 'AI in Environmental, Social and Governance (ESG) investing' and I'm building a tool that processes and evaluates mountains of data that holds essential information for ESG investing. The goal is to help sustainable-minded investors find and connect with companies striving for net-zero.

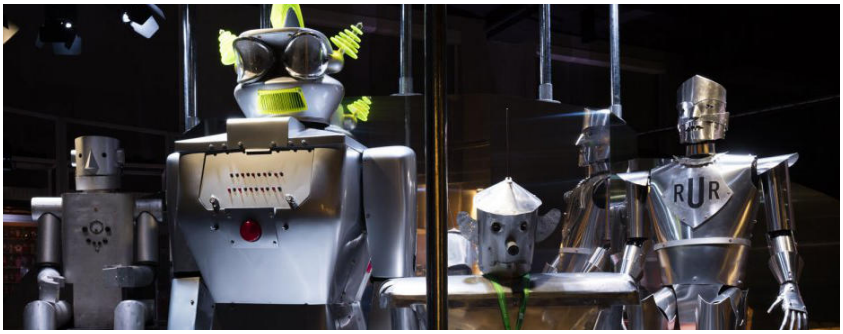
"In God we trust, everyone else must bring data"

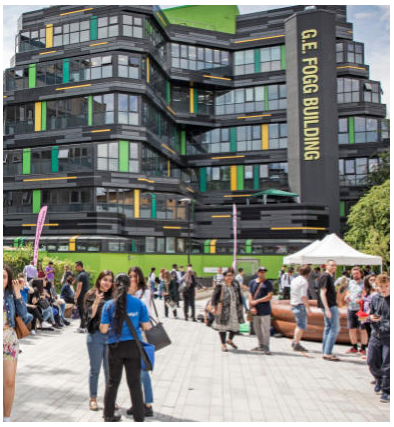
This half-serious half-joking quote from legendary Management Consultant W. Edwards Deming reminds me that we need high-quality, robust data to support the claims and predictions we make – this is especially true with AI.

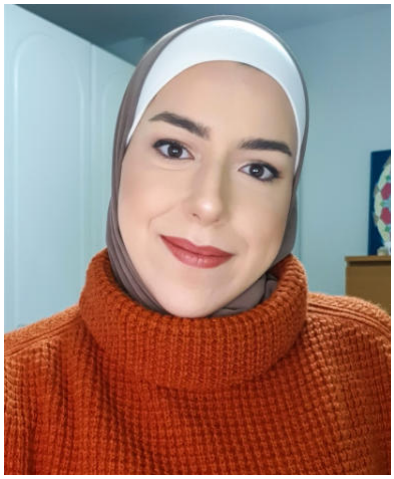
I believe AI can help tackle societal problems but if the data we train our systems on are not sufficiently diverse and unbiased, we end up embedding biases into the systems we're trying to improve and risk losing the public's trust. »

"AI is helping scientists predict climate change impacts and providing industry with new tools to help build better systems for waste management, clean energy and carbon footprint reduction."









Raghad

"The long-term goal that inspires me and keeps me going every day is to apply my AI knowledge towards impactful projects."

Microsoft's use of AI to help eradicate preventable blindness

My first exposure to AI also inspired me to explore this field. It was a portable AI-powered retinal imaging device from Forus Health and Microsoft that allowed healthcare practitioners from emerging and low-income countries to detect eye diseases such as diabetic retinopathy in patients. The device helped mitigate the lack of skilled technicians and ophthalmologists as well as provide accessible and affordable eye tests (barely taking a couple of minutes per test!), resulting in early detection and prevention of diseases that may lead to blindness if left untreated.

My DeepMind mentor Kimberly Stachenfeld

My biggest source of support and inspiration has been the DeepMind scholarship, which allowed me to join my course at Queen Mary and drastically enhance my knowledge in the field of AI. The scholarship also boosted my confidence by assigning me as a mentee to Kimberly - who has always been there to guide me towards taking positive steps to achieve my academic and career goals.

Alongside mentorship, DeepMind provided the opportunity to connect and interact to all their scholars in the UK and around the world. Everyone at DeepMind was happy to and made time to talk with the scholars about their work as well recommend to us academic resources to support our studies.

Muslamic Makers Community

During my DeepMind scholarship I wanted to grow my network and found Muslamic Makers, a community for Muslim change makers in the tech field. The friends I have made within this network have helped me on my AI journey, largely thanks to its diverse and engaging community on Slack, and their various mentorship programmes.

I particularly found their Machine Learning channel within the Slack groups a fun and active place to share knowledge with other like-minded and determined individuals. Everyone should join a network group because of the boundless opportunities to test one's ideas and learn something new.

Goal of Helping disadvantaged countries

The long-term goal that inspires me and keeps me going every day is to apply my AI knowledge towards impactful projects; specifically, the technological developments within the healthcare sector that help address health inequalities in underdeveloped countries. I also aspire to build AI-powered EdTech to help improve access to education and overcome the common barriers to learning – i.e. the lack of funding and the lack of quality educational materials.

Yann LeCun and Yarin Gal with women ML researchers at the WiML workshop during NeurIPS 2019.
Photo credit: Yann LeCun / @ylecun

NeurIPS conference

I encourage you to attend NeurIPS, a world-renowned conference in machine learning and feel awe-inspired! I attended NeurIPS in person in 2019 and presented a poster at the Women in Machine Learning (WiML) workshop. I again attended virtually in 2020 during my DeepMind scholarship.

During the WiML workshop, myself and other young ML researchers received mentoring from Yann LeCun and Yarin Gal. It was an experience that left me inspired and motivated me to further progress in this field.

Yann LeCun along with Yoshua Bengio and Geoffrey Hinton, received the Turing Award often referred to as the 'Nobel Prize of Computing'. Their work led to create an advanced form of AI based on neural networks we now call 'deep learning'.

An inspiring hero Liz Murray

Liz Murray is someone who, despite being homeless in her high school years, was accepted by Harvard to study psychology. It's incredible that she came from a very troubled background and yet achieved such amazing feats against all the odds. I recommend you watch *Homeless to Harvard*, a great feel-good movie based on her experiences and utter perseverance.

Deep Learning by Ian Goodfellow, Yoshua Bengio, Aaron Courville

This book is probably the first comprehensive textbook on the subject. It's robustly written, which makes it easy-to-digest, with good illustrative examples. I recommend it to anyone keen on pursuing studies in this field. I keep it at arm's reach for those moments when I need a quick refresher on a particular topic.

Oishi

Queen Mary University of London and **DeepMind** are key industry partners with the IoC and the Office for AI, supporting AI Masters students.

Queen Mary University of London

CattleEye

Driving dairy towards Net Zero

CattleEye is improving the lives of farmers and their livestock by developing the world's first autonomous livestock monitoring platform utilising video analytics powered by deep learning AI. Farmers simply need to install a low-cost security camera over the exit race of their milking parlour, before cloud-based AI algorithms start learning how to identify their cows, monitor their welfare and an increasing number of other behaviours.

What scaling challenges did the Applied AI programme support CattleEye to overcome?

The Applied AI programme allowed CattleEye to learn from others about how best we position ourselves when it comes to raising funding, which was ultimately successful with us closing out on a £1.7 million seed raise in May 2021.

CattleEye's technology is being showcased at COP26. Tell us your story.

CattleEye's journey began when Co-founder Terry Canning sold his first agritech business and started looking at how machine vision technology powered by AI could be applied to autonomous livestock monitoring. He teamed up with Adam Askew who had spent 12 years developing similar technology for cancerous tumour detection in the human healthcare space. They developed a demonstrator that was piloted by Tesco and raised £750,000 in seed funding. The funding allowed Terry and Adam to build the team that would go on to develop and deploy our Lameness detection platform - a neural network that could detect lameness levels on cows using footage from low-cost 2D security cameras.

The platform was rigorously tested by the University of Liverpool and they concluded that our technology was at least as good as a Veterinarian lameness expert in detecting lameness in cows. With this positive endorsement we raised a further £1.67 million and expanded across the UK and the USA.

What we are discovering is that reducing lameness levels in cows is resulting in a decrease in the carbon emission per litre of milk from these cows, which itself is a reduction of 0.5 tonnes of carbon per cow per year!

cattleeye.com

Career change: new AI postgraduate courses

The OfS is providing funding for providers to develop postgraduate conversion courses in data science and AI technologies to help address the shortage of artificial intelligence and data specialists in the UK »

New postgraduate course scholarships addresses demand for digital skills

In a year that has seen a shift to remote working and an increased reliance on digital technologies to communicate both socially and for work, the pandemic has presented many opportunities within the tech and AI sectors and for graduates hoping to gain digital skills.

The government's Digital Strategy predicts that within 20 years, 90% of jobs will require some elements of digital skills. The Department for Digital, Culture, Media and Sport (DCMS) commissioned research that predicts that data analysis skills will be the fastest growing digital skills cluster over the next five years.

Universities encourage applications to new AI and data science courses from students from all backgrounds and experiences

In June 2020, in partnership with the Office for AI and DCMS, the Office for Students launched new AI and Data Science conversion courses at 28 universities across England. They aim to accelerate the number of highly skilled graduates in AI and data science by 2,500 within 3 years and improve the diversity of the workforce by offering 1,000 scholarships worth £10,000 available for underrepresented groups, with a particular focus on Black students, women and disabled students.

The courses have been designed to support students from all backgrounds and experiences, and students with non-STEM backgrounds are encouraged to apply. Flexible working options are available to support those with work and caring responsibilities, and paid work placements are offered as part of the course. Some universities also offer free taster sessions prior to the course for potential students to find out what's involved, including Coventry University, whose two-week taster is designed to help learners assess their understanding of the disciplines involved in data science and AI, including the fundamentals of coding and other important elements like mathematics and data science thinking.

Scholarship opportunities have helped to attract more women to the courses

The courses have been hugely popular, with more than double the number of students enrolled than predicted and a significant rise in the number of women, Black students and disabled students. The success of the scholarships is particularly prevalent for women, who make up 78% of scholarship holders compared to 30% of the non-scholarship students.

Significantly, half of the cohort had either non-STEM or non-core STEM backgrounds and in the January intake, this rose to 82% of students who were enrolling to convert their non-STEM undergraduate degree. 61% of students reported that they had applied for the courses following employment and 37% clarified that their prior role was long-term and what they considered to be a 'career-job'. This suggests the programme could potentially enable a change in career direction, as well as for new graduates yet to enter the labour market. »

Office for Students OfS

Lauren and Mohana are currently studying Applied Artificial Intelligence (MSc) at Teesside University.

Lauren explains that a lack of a prior knowledge in a STEM subject shouldn't be a barrier to applying to the programme:

"When I was applying online and especially when I first came on the course in September, I was a bit worried about whether there'd be a big learning curve because I don't have any programming or coding background. I saw that the modules involved quite a bit, but when I got here everyone was in the same boat and the lecturer was amazing at providing resources and support."

Mature student Mohana, shares her reasons for applying:

"I started my career in a male-dominated industry and I have found it challenging to pursue and achieve my career milestones. I have chosen to study a masters in AI to retrain and upskill ... to restart my career in the IT industry after a career break."

Postgraduate conversion course students enrolled Autumn 2020

74% Scholarships students

46% Total cohort

Women students

40% Scholarships students

23% Total cohort

Black students

25% Scholarships students

20% Total cohort

Disabled students

You can find out more about these courses, including the full list of universities, FAQs and scholarship information on the Office for Students website at **officeforstudents.org.uk/JoinYourAIFuture**

"These courses provide a unique and welcome opportunity for students from all backgrounds to gain valuable training to tackle skills gaps and increase choice and employability options for all students, both within their local industries and across the country."

Chris Millward
Director for Fair Access and Participation at the Office for Students

Considering a career change? These myth busting facts are aimed at helping you to make an informed decision about whether or not the courses are right for you:

What sort of job or career will the courses lead to?

The UK is home to a third of Europe's AI companies, meaning graduates are ideally placed to enter employment following the completion of their conversion course.

AI and data science are fields which are used in a wide range of sectors. Students will develop skills and capabilities relevant to careers in medicine, transport, social sciences, biosciences, sports business and more.

Professions could range from jobs requiring specialised data science expertise, to roles in a business management context.

Salaries are usually generous, with itjobswatch.co.uk predicting the salary average in the UK for data science professionals to be £65,000.

Am I eligible to apply for a scholarship and if so, how can I apply?

In addition to the details in the article above, please check the website of the university you're applying to for full eligibility criteria.

Students who successfully apply for a scholarship will receive £10,000 to help with the cost of course fees, and associated costs such as childcare and transport.

Scholarships should be paid out in regular intervals across the duration of course.

Ruvimbo is an Artificial Intelligence and Data Science MSc student at Keele University. She says:

"One thing that did inspire me and still motivates me is following people in the tech industry on social media. For me it's primarily women of colour... A lot of them didn't come from a computer science background and they often share their journey and their experiences."

Maria, a mature student at Solent University in Southampton, explains how the courses have supported her to upskill her knowledge with Python programming to complement her varied career:

"I started my career as an apprentice engineer for BT in the early 90s. I remember it was challenging being a young woman in a male-dominated environment. I took a break to start a family and then I retrained. I jumped at the chance to do this course. I had no prior knowledge of Python programming but that's ok because this is a conversion course. The course would ideally suit someone who enjoys a challenge and has an analytic approach to problem solving. I found it rewarding and satisfying. In such a short space of time I learnt to create a really complex programming solution with Python and have developed a chatbot to solve a real-world problem."

#JoinYourAIFuture

Vector.ai transforms document and email-driven operations in global logistics. Their platform intelligently gathers content so that operators can respond rapidly to customer and other third-party demands. Built for logistics transactions, including customs declarations, the Vector platform is designed to drive high-performance operations teams using AI.

What scaling challenges did the Applied AI programme support Vector.ai to overcome?

We're on a pathway to rapid expansion in the freight forwarding industry. The sky is the limit and Applied AI allowed us to understand how like-minded organisations before us built up their teams so that we could do the same.

What inspired the founders to start Vector.ai?

The founders created Vector.ai because they care about the human experience at work. Repetitive tasks prevent employees from spending time on more valuable activities, like delivering great customer service, learning new skills and driving growth.

Employees at freight forwarders in particular feel the pain of monotonous tasks. They have to navigate cumbersome processes to handle a host of complex cross-border transactions and many still rely on outdated tools for communication – all of which demands hundreds of employee hours.

We want to give time back to professionals so their ability to add value in the business can soar and their job satisfaction can improve.

What have you learnt as a start-up and how have you grown as a team?

We have learnt to always ask 'why'. As a result, we are always challenging ourselves and making improvements. From product delivery to sales and marketing, no new approach is out of bounds. As an AI start-up, we recognise that our biggest advantage is an ability to adapt and learn from the market.

We have also learnt how difficult it can be for organisations to project forwards. We are only at the beginning of AI's journey into automating long-established processes. This transformative technology has more to reveal, making it difficult to imagine its impact in years to come. The kind of leaps we're making right now will seem obvious in five years' time, which is why we always need to think ahead.

Vector.ai

Vector.ai

Context Driven Workflow

8 REASONS TO GET INTO AI NOW

Katerina Giannoukou
Senior Machine Learning Engineer, AMPLYFI

Photo credit: Katerina Giannoukou

There are many reasons why the AI industry can offer one of the most rewarding, exciting and fulfilling career paths. Katerina Giannoukou, an AI engineer from AMPLYFI, a start-up using AI to transform the business intelligence industry, gives her top insights as to why an AI Masters could be the right choice now, to forge a career that can change the future.

As a Machine Learning professional, I tend to be more comfortable writing numbers and letters in long strings of code rather than in prose. In many cases, writing a blog might have been a challenge. However, in this instance the topic "reasons to get into AI now" has made my task much easier. There isn't a more exciting time than now to get involved with AI. Here's why...

Working on AI gets your creative juices flowing

Every day in AI is a creative challenge. On a daily basis, I am problem solving, thinking outside of the box, and coming up with new ways to combine data to create solutions to challenges brought by my colleagues, clients or even those I've identified myself and want to solve. In Machine Learning there are, of course, many standard techniques to draw on, but how you apply and combine them, as well as how you use the data you've got, is completely up to you.

AI is never boring

In this industry, there is always an element of surprise. We are at the cutting-edge, trying new methods that sometimes generate extraordinary and ground-breaking results. For instance, if you work on Natural Language Processing – like I currently do – small tweaks in your algorithms can help the machine to understand complex meanings in different contexts. We're trailblazers, which is awesome.

AI is perfect if you love maths...

AI provides the opportunity to put incredible maths into practice. I am a self-proclaimed maths obsessive, which means I enjoy every minute of my AI work because I get to refresh and apply my knowledge every day. Using my maths brain to solve riddles, and translating work into maths problems, makes me feel like an arithmetical Wonder Woman.

You are the master, the machine is your apprentice

It is so much fun to train a machine to think for itself and recognise patterns. You see it working independently, developing and growing like a child. You are using data to teach your machine new tricks and help it develop new skills. As your AI learns you'll feel like a teacher or proud parent – responsible and influential. Definitely my definition of fun.

... but is also great, even if you don't!

If maths isn't your thing, don't worry! With a career in AI, you get to work in a STEM environment without having to be head over heels for maths. For almost every functionality in Machine Learning there are tools to do the heavy lifting, or built-in libraries and templates, which free you up to use your innate curiosity and creativity to produce amazing results.

AI alone won't change the world, but the people who use it can

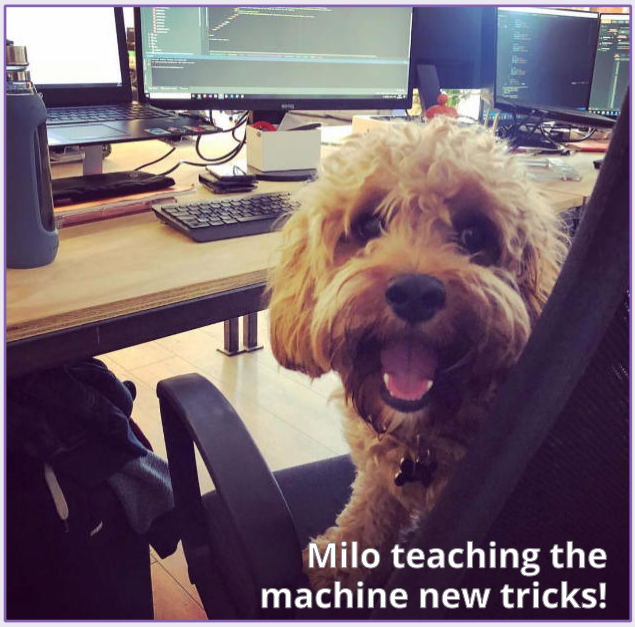
Becoming involved in AI is more than just a tech job. We are changing the world. How amazing to be involved in an industry that is shaping the future for all of us. The AI industry has a place for everyone – it's important that we include people from all backgrounds to ensure no one is left behind or ignored. This is the opportunity to develop transformative technology that works for all of us.

AI is power. Great power

As the saying goes, "with great power comes great responsibility." In my career, I have been lucky enough to see the impact that AI can have. One of the most rewarding projects I have worked on was the design and development of an AI-powered educational game for kids with Type 1 diabetes. Applying AI meant the game was incredibly interactive, enjoyable and met the complicated needs of each player. Using AI is a force for positive change. The tech has been used everywhere, from tackling climate change and preventing illegal wildlife poaching, to helping families run businesses and improving vital public services.

You'll always be the most interesting person in the room

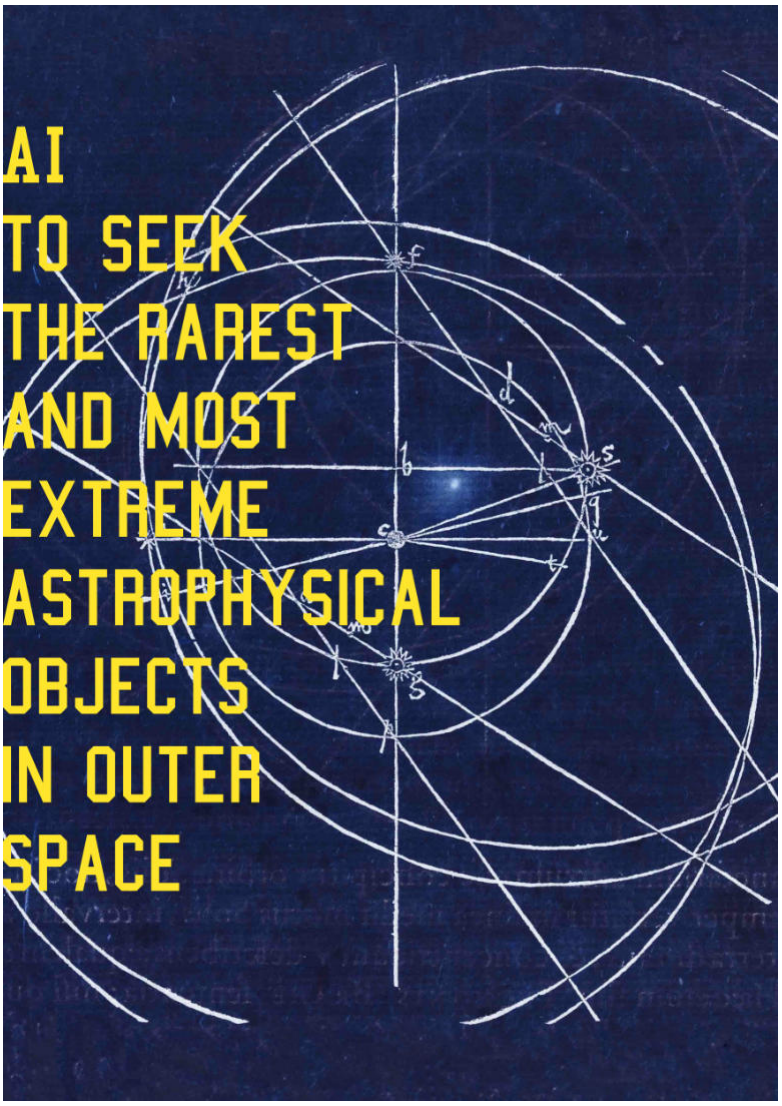
When you mention that you work in AI, people will ask about machines taking over the world, technological oblivion coming, the rise of the machine etc. It's great fun to be the 'insider' sharing industry knowledge with friends and letting them know that everything is going to be fine. We're a very, very long way away from the age of the Terminator! I will play the role of myth-buster a few pages later. ***So, find a grad or post grad you love and make it a profession!***



AMPLYFI is a key industry partner with the IoC and the Office for AI, supporting AI Masters students.

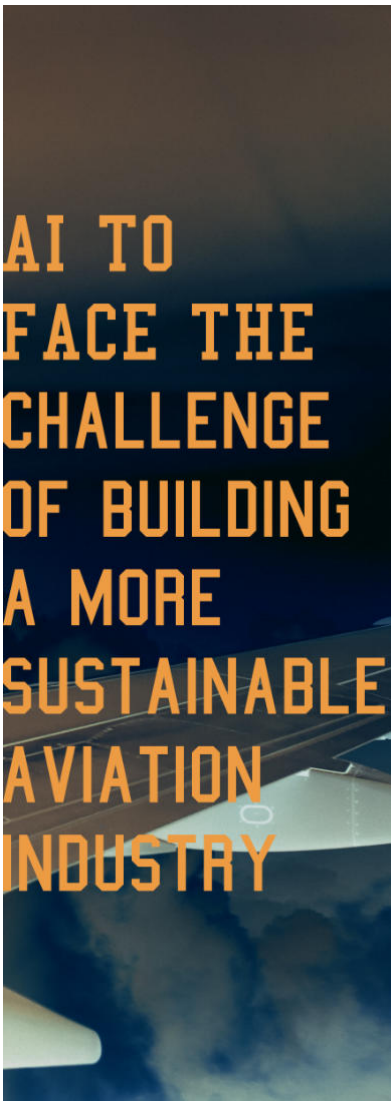
TURING AI F

The Turing AI Fellowships initiative was created to retain, attract and develop the best and Research and Innovation, The Office for AI, and The Alan Turing Institute. Fellows will pioneer of building a more sustainable aviation industry, to democratising safe and robust AI.



ANNA SCAIFE, UNIVERSITY OF MANCHESTER

Anna's Turing AI Fellowship focuses on AI for discovery in data intensive astrophysics. In this era of big data astrophysics, radio telescopes like the Square Kilometre Array have data rates so large that the raw data cannot be stored, and even using the compressed data products requires a super-computer. Anna will develop new machine learning approaches to deal efficiently with these huge data volumes, and address the question of how we can still allow for discovery when such processing is completely automated.



TIMOTHY DODWELL, U

In this safety-critical industry, th
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ELLOWSHIPS

brightest AI researchers. The Turing AI Fellowships are being delivered in partnership by UK unique and exciting areas of research in artificial intelligence, from addressing the challenge

NIVERSITY OF EXETER

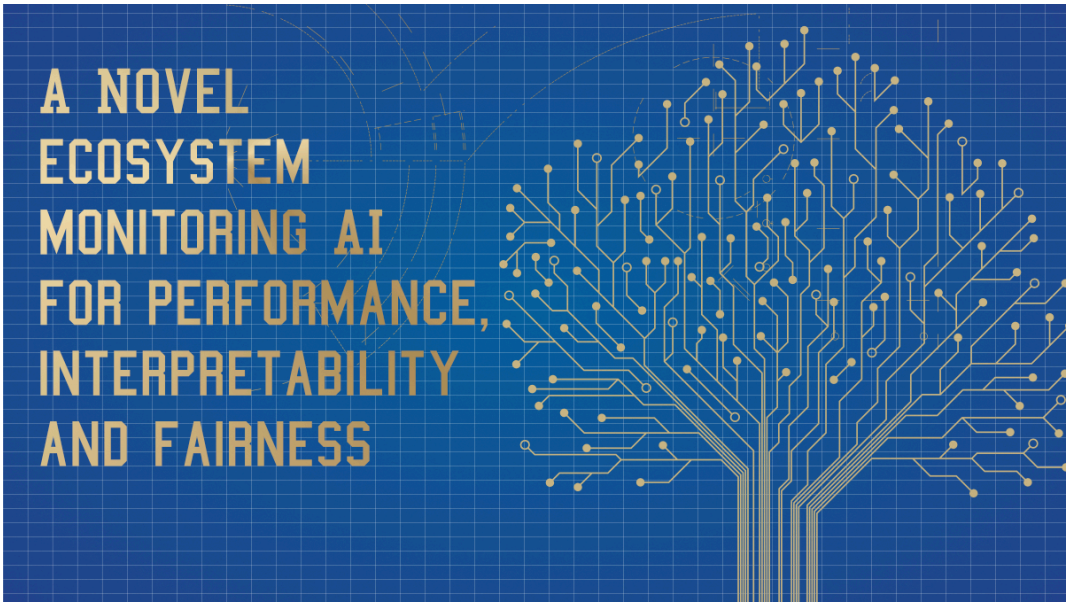
e aim is to design aircraft with a quires an enormously costly en- an experimental test "pyramid", of small-scale tests, hundreds of ful of tests of the full system. Tim hich fuse high-performance sim- ental data to build a virtual test aking the ultimate decision: "Is safe to fly?"

MARIA LIAKATA, UNIVERSITY OF WARWICK

Maria's work as a Turing AI Fellow utilises language data obtained from the widespread use of digital technology such as social media as well as smartphone data to develop novel natural language processing methods for automatically capturing changes in user behaviour over time. This work has direct applicability to mental health as it will help provide experts with evidence for personalised changes in mood and cognition from everyday use of digital technologies. »

YARIN GAL, UNIVERSITY OF OXFORD

Probabilistic approaches to deep learning AI, such as Bayesian Deep Learning, are already in use in industry, academia and healthcare, but challenges remain in deploying it safely and responsibly. Yarin will tackle the issue of assessing safety by creating public challenges for the AI-community, derived from real-world applications of AI. The public challenges will form a bridge between practitioners and AI researchers, which in turn will reveal new research opportunities for the AI community and push the development of new, safe and robust AI tools available to all.



NEIL LAWRENCE, UNIVERSITY OF CAMBRIDGE

Neil will focus on machine learning systems design, including AI-assisted design and monitoring of such systems to ensure they perform robustly, safely and accurately in their deployed environment. The project will explore the entire development pipeline, from data acquisition to decision making. Neil proposes an ecosystem that includes system monitoring for performance, interpretability and fairness. He will place these ideas in a wider context that also considers the availability, quality and ethics of data.

THE TURING AI FELLOWSHIPS

The Turing AI Fellowships are a £46 million initiative by the UK Government to retain, attract and develop the best and brightest AI researchers. The Fellows are pioneering unique and exciting areas of research in AI, working in collaboration with partners from other sectors to accelerate the impact of their research. The Partners have already committed to contributions valued in excess of £23 million. The Fellows' research spans areas such as addressing the challenge of building a more sustainable aviation industry, developing new AI to help clinicians to choose the best treatment for hospital patients post-diagnosis, synthetic biology and drug design, financial modelling, and autonomous vehicles.

The investment in Turing AI Fellowships will boost the UK's global reputation as a great place to study, invest or work in AI by contributing to a diverse and sustainable AI research and innovation ecosystem, and enabling enhanced engagement between industry and academia.

The **first five Turing AI Fellowships** awarded during the pilot phase of the investment signalled the UK's ambition to maintain and grow its global leadership in the development of AI methodologies and enhance our research power in the field.

The **Turing AI Acceleration Fellowships** were awarded with the aim of accelerating the careers of fifteen of the highest potential AI researchers towards a world-leading position by the end of the five year award.

The prestigious **Turing AI World-Leading Researcher Fellowships** have been awarded to exceptional AI researchers to enable the building of centres of excellence in key areas. This has allowed some of the brightest minds in AI research to remain in or move to UK academia thereby growing the UK's international competitiveness and reputation in AI. They will also train the next generation of AI researchers and be global ambassadors for AI in the UK.

All fellows will actively engage with questions around AI and ethics, and responsible research and innovation, throughout their activities.

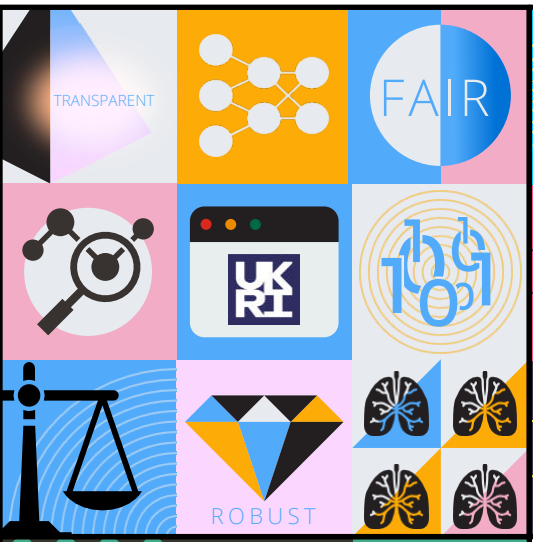
The initiative is being delivered in partnership by UK Research and Innovation, The Office for AI, The Alan Turing Institute, and the Department for Business, Energy and Industrial Strategy.

COLLABORATE WITH A FELLOW

The Turing AI Fellowships are intended to enhance connections between academia and industry through supporting cross-sector collaborations and enabling the two-way flow of knowledge and people. This will accelerate the impact of the world-leading AI research being carried out by the fellows and benefit UK industry through the creation of new academic-industry collaborations and partnerships.

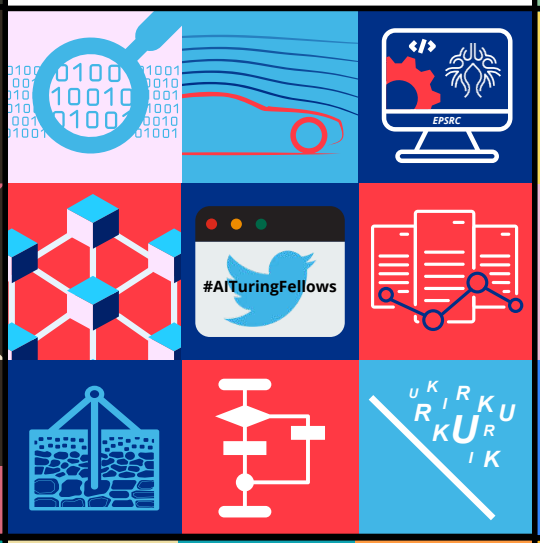
Visit gov.uk/the-turing-ai-fellows to contact the Fellows directly if you're interested in finding out more about their research programmes.

General enquiries about the Turing AI Fellowships investment may be sent to AI.robotics@epsrc.ukri.org.



Up to £20 million was invested by the UK Government to fund fellowships with the aim of accelerating the development of high potential mid-career AI researchers into future AI leaders in their institution, and in the national and international research community.

Visit **gov.uk/officeforai** for the full list of Turing AI Fellows supported by funding from the Government.



Building trustworthy machine learning to benefit society and help people embrace new services

Making ML more fair, transparent and robust to deliver better outcomes from healthcare to criminal justice.

Dr. Adrian Weller, University of Cambridge

AI to accelerate molecular design

Helping to build efficient batteries, solar panels and organic LEDs. As well as accelerating the drug discovery process, leading to affordable medicines.

Dr. Jose Hernandez Lobato, University of Cambridge

Applying natural selection as a model to solve problems using AI

Engineering a digital eco-system of predators and prey, algorithms can hit on robust and high-quality solutions through survival of the fittest.

Dr. Per Kristian Lehre, University of Birmingham

Developing AI to help clinicians treat cancer

Using AI to assist treatment decisions for cancer patients by providing more detailed information in a more accessible format, and improving efficacy and efficiency of clinical trials.

Professor Christopher Yau, The University of Manchester

TURING AI ACCELERATION FELLOWSHIPS

AI, thinking at light-speed

Exploring how ultrafast information processing using light signals instead of electrical currents could lower the power consumption of AI systems.

Dr. Antonio Hurtado, University of Strathclyde

Establishing the machine learning foundations for digital twins

Helping industry to perform accurate but simulated "what-if" scenarios using digital representations of real-world physical systems and assets.

Dr. Theo Damoulas, University of Warwick

Developing an AI clinician to support-front line medical care

To develop AI at the interface of artificial and human intelligence that, through interactions, can learn the skills of a human expert. For example, a medical doctor treating patients.

Professor Aldo Faisal, Imperial College London

Helping people regain their independence with AI-powered wearables

Enabling movement-independent control and treating disease and recreation.

Professor Damien Coyle, Ulster University

Improving AI dialogue through natural language

Developing AI-driven systems with reasoning capabilities which are able to read and comprehend text, and formulate an answer when presented with a question. Bringing us closer to human-like AI.

Professor Yulan He, University of Warwick

Designing a new way to label data for reliable and trustworthy AI

Empowering users and AI practitioners with tools to understand the effect of annotations and improve the transparency and efficiency of AI services.

Dr. Raul Santos-Rodriguez, University of Bristol

Developing citizen-centric AI Systems

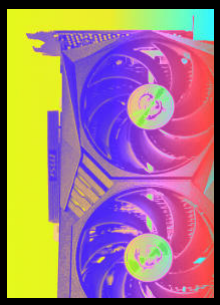
Supporting a range of uses, from using crowdsourced information to track the spread of diseases, to helping people manage their energy needs.

Dr. Sebastian Stein, University of Southampton

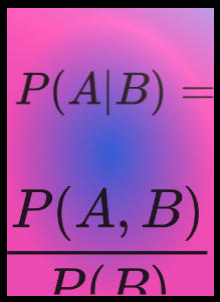
TURING AI WORLD LEADING RESEARCHER FELLOWSHIPS

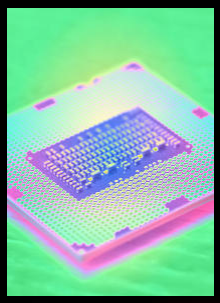
PROFESSOR ZOUBIN GHAHRAMANI
University of Cambridge

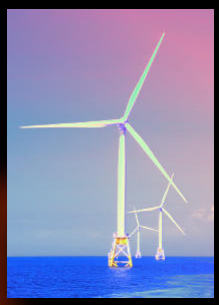
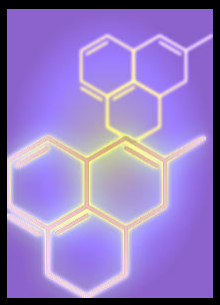
PROFESSOR SAMUEL KASKI
The University of Manchester









"These five internationally-recognised researchers appointed as the first Turing AI World-Leading Researcher Fellows will help enable us to attract top talent from across the globe and ensure that the UK stays at the forefront of AI research and innovation. This expertise will increase the UK's capabilities in AI and equip us to face greater and more complex challenges."

- Sir Patrick Vallance
UK Government
Chief Scientific Adviser

Advancing Modern Data-Driven Robust AI

Professor Ghahramani aims to develop the new algorithms and applications needed to address limitations faced by the AI systems that underpin technologies such as speech recognition and autonomous vehicles.

This includes ensuring they can better adapt to new data, and apply data-driven machine learning approaches to simulators to understand complex systems.

Human-AI Research Teams - Steering AI in Experimental Design and Decision-Making

Through his fellowship, Professor Kaski aims to overcome a fundamental limitation of current AI systems, that they require a detailed specification of the goal before they can help.

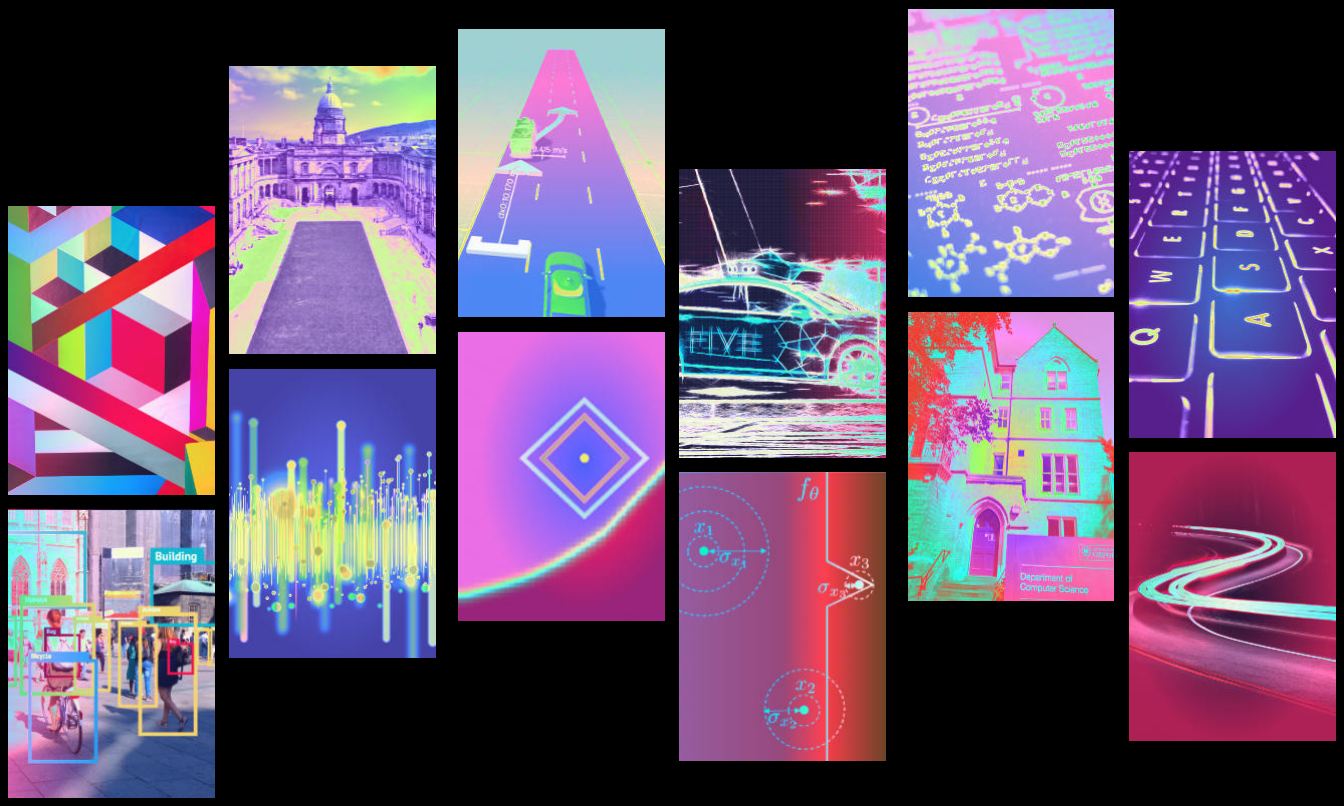
In difficult design and decision tasks such as drug design we often cannot give that, because the desired outcomes uncertain and evolving.

The new tools will be applied to help in drug design and to improve diagnoses and treatment decision making in personalised medicine.

PROFESSOR MIRELLA LAPATA
The University of Edinburgh

PROFESSOR PHILIP TORR
University of Oxford

PROFESSOR MICHAEL WOOLDRIDGE
University of Oxford



TEAMER – Teaching Machines To Reason Like Humans

Professor Lapata aims to develop an AI system, inspired by the human brain, that is capable of advanced reasoning and able to draw conclusions from large and varied sets of data.

This would address the limitations of current AI systems which cannot match the sophistication of the human brain in integrating large amounts of information from different sources.

Robust, Efficient and Trustworthy Learning

Professor Torr aims to make deep neural networks more robust.

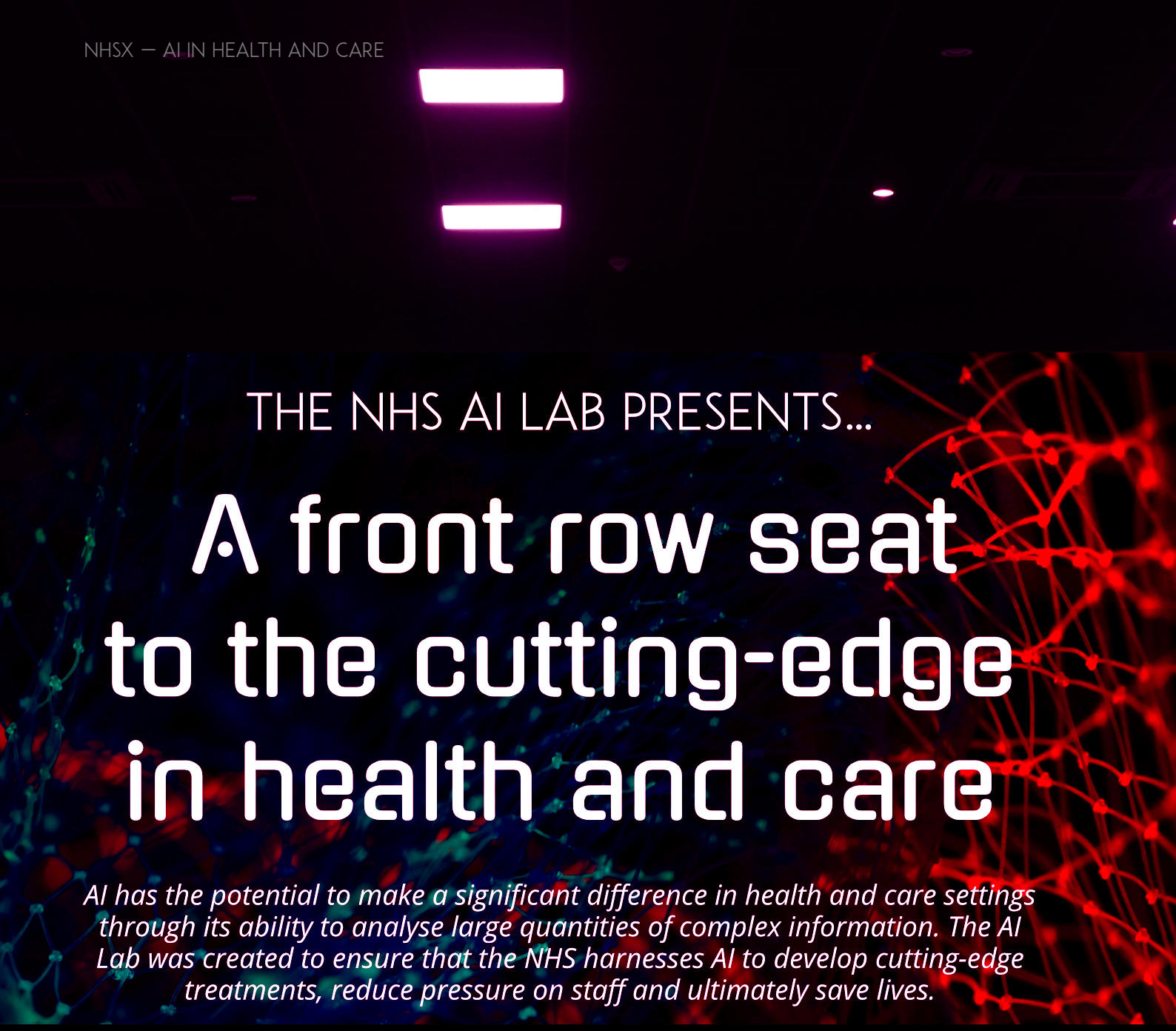
Deep networks are widely used in applications from fraud-detection to self-driving cars but are have surprising vulnerabilities.

Through his fellowship Professor Torr will create a new centre of excellence. The centre will make deep learning reliable, robust and deployable as well as capable of efficiently handling the enormous quantities of data they will be fed with.

The Large Agent Collider: robust agent-based modelling at scale

This research aim to improve the agent-based AI models that are increasingly used in sectors such as financial modelling and logistics.

Professor Wooldridge's team have previously used agent-based models to understand the causes of catastrophic collapses in global markets, so called "flash crashes", and they will continue this work in the project.



THE NHS AI LAB PRESENTS...

A front row seat to the cutting-edge in health and care

AI has the potential to make a significant difference in health and care settings through its ability to analyse large quantities of complex information. The AI Lab was created to ensure that the NHS harnesses AI to develop cutting-edge treatments, reduce pressure on staff and ultimately save lives.

The NHS AI lab exists to ensure that the opportunities artificial intelligence brings to health and social care are made accessible to everyone.

This means working to ensure new technologies are introduced safely and ethically.

At the Lab, we're not only making sure that AI technologies work and are fit for purpose, but that their adoption fits with the wider digital transformation happening across the world. Now that the pandemic has impacted our goals to improve access to health and care, we are all looking at the opportunity of technology as a great enabler. We are looking to learn from other sectors and share our learning too (Check out *Creating an International Approach to AI for healthcare* on page 109).

NHSX recently published a draft data strategy, *'Data Saves Lives: Reshaping health and social care with data'*, which highlights the importance of patient data for vital research and innovation like AI.

The data strategy and the National AI Strategy have signalled the need for a definitive AI strategy for the healthcare sector that supports AI technologies from inception to implementation, streamlining regulation, routes to market and supporting the workforce to understand the benefits of AI and develop the skills to use it. Initial development of our **National AI in Health and Adult Social Care Strategy** is underway.

The future for health AI

It's already evident that AI can take a very typical data source, like images, and find something more in it than we can with the human eye. But what is new and emerging, is the opportunity to transform how care is delivered and for patient-facing healthcare professionals to spot trends and patterns in ways they've not been able to before.

Instead of taking a passive approach to managing long-term conditions, where people's care is directed by healthcare professionals and patients are often required to visit a healthcare professional regularly, now there is the potential for technology to provide people with information they need to really take control of their own healthcare at home. AI can help them to be aware of when they need to go and who they need to see.

Using AI-driven tech in this way could not only provide some immediate solutions to the backlog of care caused by the pandemic, it offers the potential for new solutions that will change our attitudes to healthcare for good.

£140 million investment in innovative pilots

The NHS AI Lab is supporting the testing, evaluation and scale of promising AI-driven technologies through the £140 million AI in Health and Care Award.
This includes automating early lung cancer detection and developing deep learning software that can improve the detecting and management of stroke.

We want to see a future where…

- **People will use AI-driven monitoring, via devices like smartphones,** to manage long term conditions from home before being referred to the best care setting
- **Clinicians will be assisted by AI diagnostic tools** to identify diseases and the patients most at risk of developing specific conditions
- **AI-driven management systems will give hospital managers a real-time view of waiting times and bed capacity**, enabling them to move patients more efficiently through the system
- **Public health officials and local authorities will use predictive AI tools** to understand the current and future care needs in specific areas

If you are an AI developer, data scientist, work for the NHS or social care and are looking to adopt or deploy data-driven tools for health and care, get involved by joining the AI Lab's Virtual Hub, a community space for people to interact and share knowledge and ideas about AI technology in health and social care. Contact **ailab@nhsx.nhs.uk**.

C the Signs

Fighting cancer with early diagnosis

C the Signs is an award-winning platform founded by doctors. Using AI mapped with the latest evidence, the tool is used by doctors to identify patients at risk of cancer at the earliest and most survivable stage of the disease. Covering the entire spectrum of cancer, C the Signs can identify which cancer(s) a patient is at risk of and what test, investigation or referral they need in less than 30 seconds.

What piece of advice would C the Sign give to a founder who's thinking about joining Applied AI?

Applied AI is a fantastic opportunity to be with like-minded founders and CEOs solving some of the world's biggest challenges with AI. The programme catapults companies forward to help achieve their goals and establish long-term networks and relationships to continue with learning and growth.

What is C the Sign's story? What inspired the founders?

Our co-founder Bea met Joe in the emergency department when she was working as a junior doctor. He came in very unwell, and Bea had the difficult task of diagnosing him with pancreatic cancer. He died three weeks later. His words stayed with her, 'Why was my cancer picked up so late?' Insight from Cancer Research UK shows currently half of all patients are diagnosed in the late stages of the disease, with less than 35% surviving to 5 years. If diagnosed early over 80% of patients would survive for 10 years or more. The power of early detection and the impact it could have on patients' lives and communities across the world spurred the founders to invent a solution where every patient can survive cancer.

How are you supporting the pandemic effort?

Over the course of the pandemic, C the Signs has adapted to support with the rapidly changing environment in healthcare, enabling patients to undergo cancer risk assessment and referral from the safety of their own home. The Applied AI programme helped to establish processes to work effectively as a remote team, and to hire, scale and grow through the pandemic, whilst overcoming the uncertainty and challenges that COVID-19 brought. **Today, C the Signs is being used in over 1000 NHS primary care practices** to accelerate early cancer detection for patients.

cthesigns.co.uk

NHS X

Safe, ethical, and effective AI in the NHS

AI promises to enhance the way healthcare is delivered and improve patient outcomes. It can increase the speed of access to care, improve diagnostic accuracy and reduce costs. But to get this right, we need to build the trust and confidence of both the public and the health and care workforce. Confidence that AI brings tangible benefits and is designed in a way that seeks to address health and care inequalities.

The ethics of AI

There is a risk that data-driven technologies such as AI will exacerbate existing health inequalities. Research from the US has revealed that the use of AI (for example, for triaging support) has disadvantaged some minority ethnic populations. **The NHS AI Lab is collaborating with academia, the third sector and other public bodies to ensure that AI is used to successfully close, as opposed to widen, gaps in health outcomes.** Our AI Ethics Initiative invests in research and practical interventions that complement and strengthen existing efforts to validate, evaluate and regulate AI-driven technologies in health and care. Its focus is on countering the health inequalities that may arise from the ways that these technologies are developed and deployed.

Evaluation, Evaluation, Evaluation

Evaluating the applications of AI in health and social care is key to the safe and effective deployment of this technology. It is also essential for increasing the trustworthiness of AI through evidence standards. **The NHS AI Lab is currently funding and evaluating 80 technologies that target the most pressing issues for health and care through the £140m AI in Health and Care Award.** It is hoped that current hospital trials will show results like reduced waiting times for electrocardiogram tests, increased speeds of cancer diagnosis and evidence of cost efficiencies. These AI Award projects are teaching us a great deal about how to clinically evaluate AI and report results - advancing our knowledge on how to appropriately regulate AI.

Standardising regulation

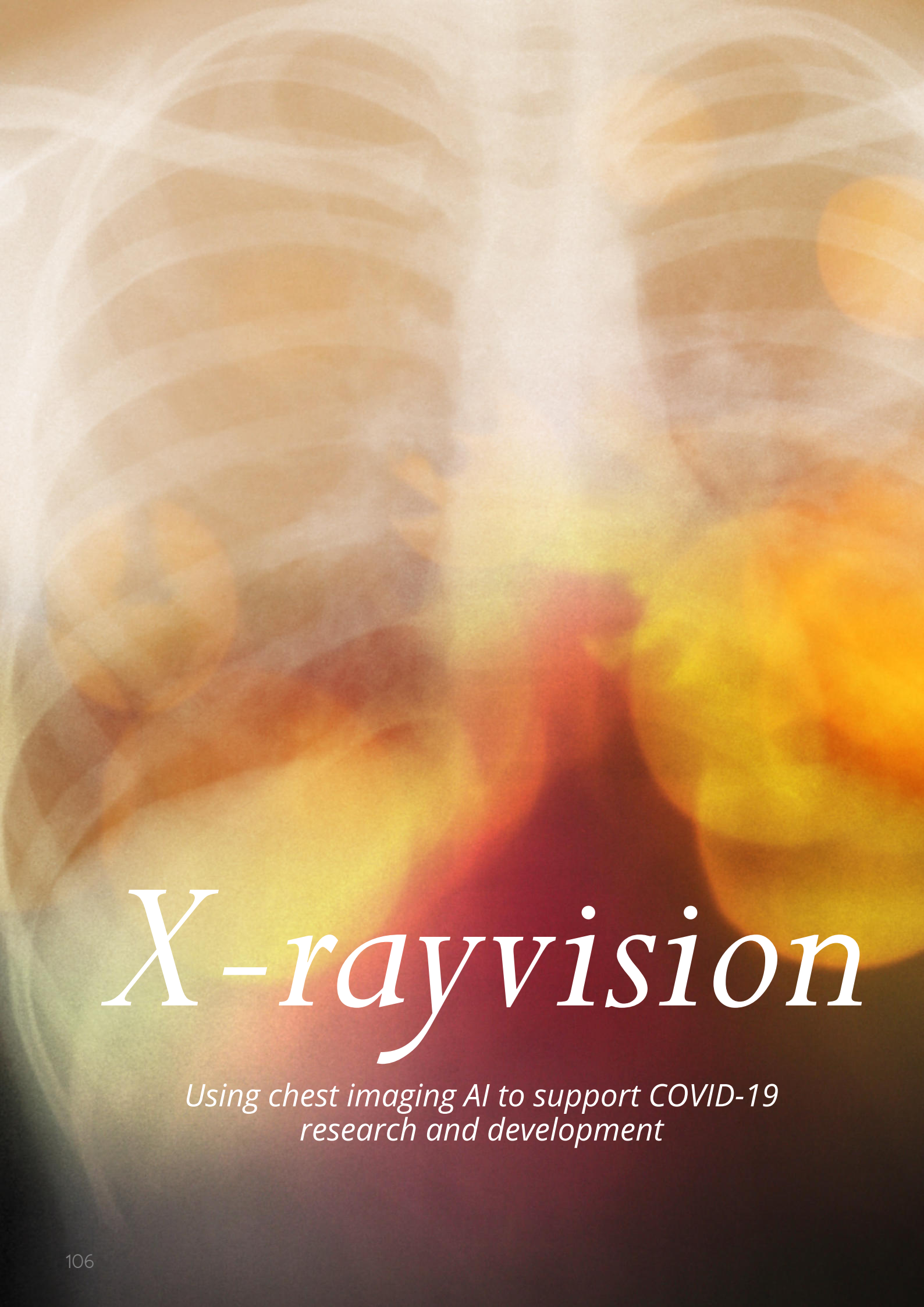
The UK faces a unique and pioneering opportunity to transform the regulation of 'software as a medical device', ahead of other countries. The Medicines and Medical Devices Act is a key part of this, and it will grant statutory powers to update the UK's current regulatory framework for medical devices. **Achieving smart regulation for AI in health and care is key to fostering innovation and promoting patient safety.**

A new strategic approach

Our ambition is a future where AI is deployed in a safe, ethical and effective way that benefits the public and healthcare professionals. The richness of the data held with the health and social care system, gives the UK a unique opportunity to lead the way in the deployment of AI in the sector. We are capitalising on this opportunity by drafting a strategy for AI in health and adult social care to sit alongside the wider National AI Strategy, and the draft National Data Strategy launched in June 2021 by NHSX.

These three UK strategies share a vision for data-driven technology that has the potential to transform people's lives.

nhsx.nhs.uk/ai-lab



X-rayvision

Using chest imaging AI to support COVID-19 research and development

Chest scan images are a vital tool for researchers in the response to COVID-19. However, incomplete datasets often make it difficult for researchers and developers to rigorously test hypotheses or tools that could help improve the healthcare response to the disease and save lives.

The National COVID-19 Chest Imaging Database (NCCID) - *a joint initiative established by NHSX's AI Lab, the British Society of Thoracic Imaging (BSTI), Royal Surrey NHS Foundation Trust and Faculty* - provides managed access to a complete, and representative sample of pseudonymised chest scans from suspected COVID-19 patients across the country. With this data, the NHS hopes to enable the development of software that can help doctors and researchers understand the impact and progression of the disease, assess the severity of the condition in individual patients, identify factors that may complicate recovery, and prioritise patients whose condition is most likely to deteriorate.

Using the database to evaluate safety and effectiveness

The database is being used used by researchers like the team at Addenbrooke's Hospital in Cambridge who are developing an algorithm based on the NCCID images to help inform a more accurate diagnosis of people with COVID-19.

When people arrive at hospital with potential COVID-19 symptoms and have not yet had a confirmed test, the algorithm uses visual signatures of the

Dom Cushnan
Head of Imaging, NHS AI Lab

Photo credit: Cambridge University Hospitals

virus from chest scans to compare the patterns in the patient's imaging with those seen previously in the NCCID to get a more accurate diagnosis and prognosis. Testing algorithms like this one requires datasets that are representative of the population they will eventually encounter in clinical use.

As part of this process, the NHS AI Lab created a separate dataset used solely to assess the performance and fairness of AI models. Because the performance of AI models is linked to the characteristics of the data that they have been trained on, it is important that models are tested on previously unseen and population-representative datasets. Healthcare providers often have little assurance that the AI products they purchase will deliver real, measurable results for practitioners and patients. Now, AI tools can be validated using unseen NCCID data that reduces the potential for bias and provides NHS commissioners and healthcare regulators with the evidence to judge how safe and fair the technology is, whether it is effective and how well it will perform in large-scale clinical use.

Rigorous data management processes are in place to ensure data is collected and accessed securely, efficiently and safely. Researchers or developers wishing to access the database and use the platform must have their requests assessed by a committee of scientific, technology, »

information governance and ethics experts. All of the scans in the library are stripped of any identifying patient details by each hospital trust before being submitted to the national collection, so that researchers only have access to pseudonymised information.

Reducing the pandemic impact with AI

The NCCID is now a major national resource, with contributions from more than 23 NHS trusts, containing over 55,000 X-ray, MRI and CT images. The collection is now large enough to be able

> *"Applying the power of Artificial Intelligence to over 55,000 NHS scans is a fantastic opportunity to help us quickly detect disease patterns and treat patients with this new virus."*
>
> Dom Cushnan,
> Head of Imaging, NHS AI Lab

to provide sample datasets of a sufficient size and variety to ensure robust model testing and development.

Teams from 11 UK university consortiums are already using the NCCID to develop and test tools for the diagnosis, management and prioritisation of COVID-19 patients.

The success of the NCCID has resulted in early stage development of a national medical imaging platform. This would broaden the chest imaging collection to include large volumes and types of medical imaging for use in testing and developing AI technologies for a range of health and social care needs.

To access NCCID data for research or investigations into COVID-19, please read the information on **how to access the database** on the NHSX GitHub website.

The NCCID involves...

23 NHS Trusts

around 18,000 patients

over 55,000 images

and **14 approved data users** making the NCCID one of the largest initiatives of its kind in the UK

Creating an international approach to AI for healthcare

AI has the potential to revolutionise our global approach to healthcare, but we need a coherent global consensus on governance too.

The use of AI in health systems has accelerated globally - especially during the pandemic - with different applications being tested and put into practice across diverse areas of health system design and delivery. However, AI-driven technology development in healthcare is outpacing the creation of supporting policy frameworks and regulation.

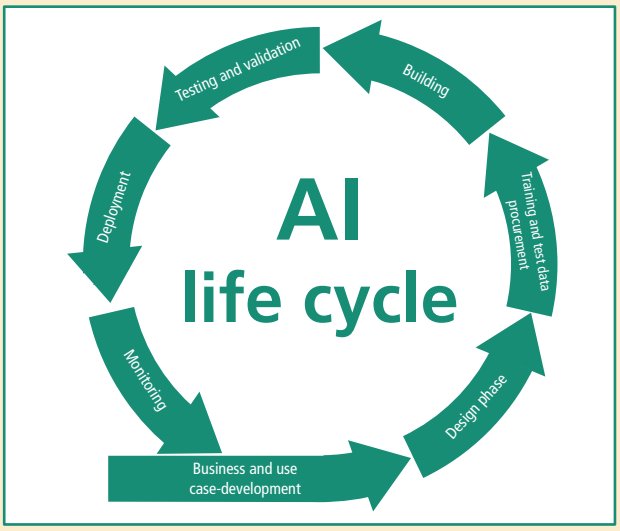
The NHS AI Lab at NHSX was commissioned by the Global Digital Health Partnership (GDHP) to understand the current use of AI-driven technologies across member countries, and the supporting policies and regulations in place. By doing so, the Lab was able to identify gaps and opportunities for international governance and coherence towards ensuring AI-driven technologies are properly governed, regulated and used for maximal benefit in health systems.

The resulting paper: ***AI for healthcare: Creating an international approach together*** is a step towards providing much needed policy guidance to the international health community. »

The AI life cycle

Any policy recommendations or frameworks for the use of AI-driven technologies in healthcare need to cover the whole AI life cycle. The illustration below shows the AI life cycle:

As described, the development of AI-driven technologies in this life cycle is an iterative process involving scoping, designing and building, then deploying the AI-driven technology with continuous monitoring, followed by improvement as and when the need arises. In order to implement AI-driven technologies successfully within a health system, countries need to consider and support each step in the AI life cycle: Leadership and oversight, Ecosystem, Standards and regulation, and Engagement.



Example of a simplified AI product life cycle. Image based on and reproduced with permission from the ICO.

Four categories supporting implementation

Spanning across the AI life cycle, the paper outlines four strategic categories and associated policy recommendations to support policymakers to implement AI-driven technologies into their health system:

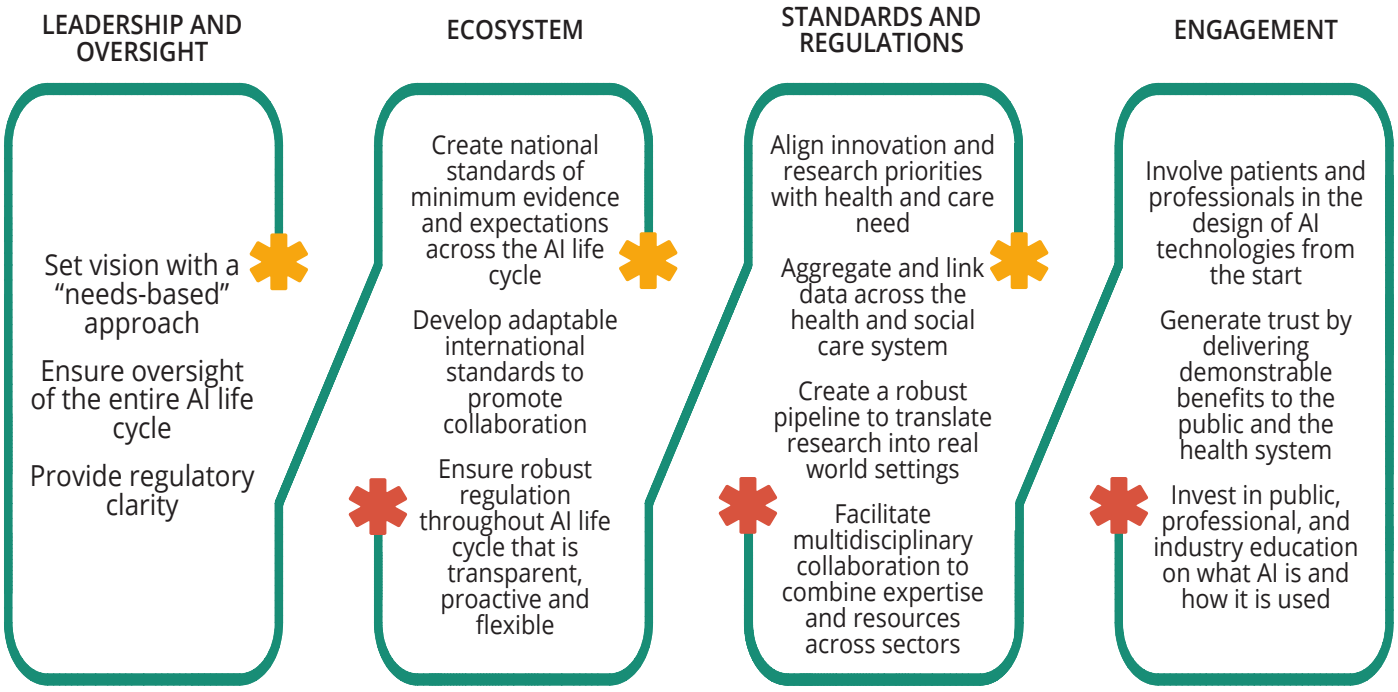
Leadership and oversight is necessary to ensure that countries take a 'needs based' approach to AI driven technology development and use within their health systems and to ensure that AI-driven technology use creates maximal benefit when it comes to health outcomes. This vision of AI-driven technology use should direct oversight across all stages of the AI life cycle, along with supporting activities such as research, funding, and workforce development.

Policies should focus on the entire **ecosystem** of AI R&D rather than focusing on just one aspect of the life cycle. This requires measures to aggregate and link data, public-private initiatives to address skills and funding gaps, and a robust research to deployment pipeline.

National **standards and regulatory** processes should ensure interoperability, safety, and efficacy of AI-driven technologies in health settings. Regulation should recognise the distinct nature of AI within digital technologies, and should also be transparent and shared publicly to build a trustworthy environment.

Engagement with stakeholders such as patients, healthcare practitioners, and industry should be proactively pursued through highlighting the demonstrable benefits of specific uses of AI-driven technologies in health systems. A focus on building trust around specific uses of AI-driven technologies will ensure that AI driven technology development and use is informed by purposeful and educated conversations with stakeholders. Working with healthcare professionals and the higher education sector to update medical education and accreditation for AI-driven technologies, as well as to co-design future AI-driven technologies, will help ensure a frictionless deployment of AI-driven technologies that complements healthcare professional workflows.

Four strategic categories and associated policy recommendations to support policymakers to implement AI-driven technologies into the health system

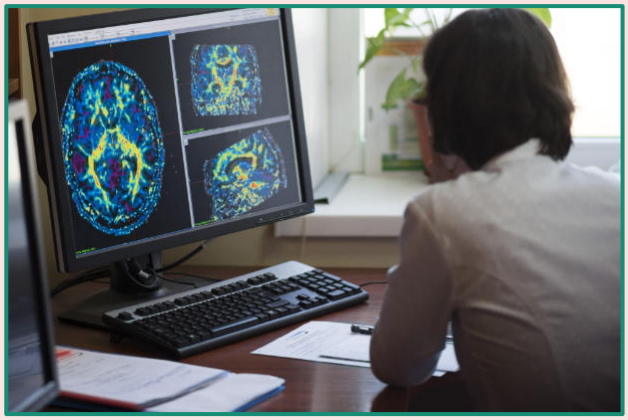


Next steps

The authors of the paper hope the international health community can use the policy recommendations as a base as they create national and regional approaches to developing and using AI-driven technologies in their health system.

The NHS AI Lab thanks the GDHP for supporting the team to conduct this research during what is a difficult time for the international health community. The authors hope the insight and recommendations shared in the paper are useful for all countries for ensuring the safe adoption of effective AI-driven technologies that meet the needs of patients, the public, healthcare professionals and the wider health system.

Dr. Indra Joshi
Director of AI for NHSX



Within the UK, we look forward to working with partners to embed these findings into their thinking and programmes. The NHS AI Lab is committed to continuing to learn from international colleagues and to bring in better and safer access to AI-driven technology for the NHS and its patients.

Read the full paper **AI for healthcare: Creating an international approach together** at nhsx.nhs.uk/ai-lab

Diagnosing melanoma

Every day in the UK, 44 people are diagnosed with melanoma, a cancer of the skin. According to statistics published by Cancer Research UK, it is the fifth most common form of cancer - and incidence of the disease has more than doubled since the early 1990s.

But for doctors, it is often a difficult disease to detect. Cases can be misdiagnosed and CRUK say around one in ten cases is confirmed at a late stage, making effective treatment harder.

Dr. Emily Clarke is a hospital doctor working in histopathology. Histopathologists are specialist doctors who observe changes in cells that indicate the presence of disease. She is involved in research that could see AI being used to help doctors make quicker and more accurate diagnoses – essentially a system that will provide a valuable second opinion.

Currently, all cases of melanoma are confirmed by a histopathologist examining cells removed during a biopsy. Those doctors are making very fine judgement calls based on what they are seeing down a microscope or on a computer screen.

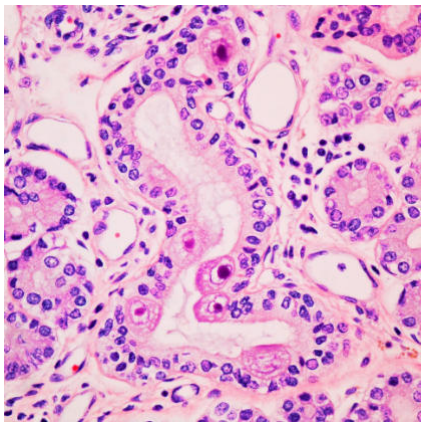
Around one in six cases is misdiagnosed and one in five cases is subject to specialist review because a doctor is uncertain whether changes in the cells are cancerous. However, digitisation of pathological samples has opened up the possibility that technology, and AI in particular, can be harnessed to assist histopathologists.

> *"Caught early, melanoma tumours can be removed and successfully treated. But this is a notoriously difficult disease to diagnose. We are investigating how AI could assist histopathologists in their diagnosis."*
>
> Dr Emily Clarke

16 UKRI AI Centres for Doctoral Training at universities across the UK - and backed by up to £100 million - are delivering 1000 new PhDs over eight years.

The UKRI CDT in AI for Medical Diagnosis and Care at the University of Leeds is training a new generation of responsible researchers and innovators with the expertise and knowledge to transform the pace and precision of medical diagnosis and care through the application of AI.

Photo credit: Dr. Emily Clarke



The University of Leeds

Dr. Clarke has been awarded a Medical Research Council Fellowship to further her investigation, overseen by experts in digital histopathology, melanoma tumour biology and artificial intelligence applied to histopathology. She is also part of a wider team of researchers at the University of Leeds pioneering how AI can enhance medical diagnosis and care across a number of fronts, with a particular emphasis on cancer.

The University of Leeds runs one of the 16 AI Centres for Doctoral Training (CDT) in AI established by UK Research and Innovation, the government agency responsible for fostering research and development. It allows researchers to undertake a major investigation into AI and/or machine learning - and to earn a PhD.

At Leeds, 10 scientists a year join the scheme, and when it is fully operational around 50 people will be developing new AI ideas for medicine and health.

David Hogg is Professor of AI at Leeds and Director of the CDT. He says the CDT will build on the international reputation the UK has for being a world leader in AI.

He said: "These scientists will be at the forefront of a technology that is going to change healthcare. Some of it we can predict. It will mean faster and more accurate diagnoses. In some instances, it will assist doctors in making difficult decisions based on the interpretation of scans or other medical tests.

"The CDT will also provide highly skilled scientists who can apply AI to healthcare. The Government is committed to transforming cancer survival rates in the UK and AI systems will be among measures to achieve that."

There are nine other research projects at Leeds investigating the way AI can tackle cancer. »

Baroness Nicky Morgan, then Digital Secretary, met with Dr. Emily Clarke, Professor David Hogg and UKRI-funded PhD researchers to discuss how AI can improve cancer care. *Picture taken in 2019*

The University of Leeds already has strengths in computer science and AI, and a strong partnership with Leeds Teaching Hospitals NHS Trust (LTHT), which is rapidly advancing the digital revolution in health settings.

LTHT has led the creation of a digital pathology service with nine other hospitals. Known as the Northern Pathology Imaging Cooperative, one of its aims is to develop intelligence tools to help with cancer diagnosis.

Digital repositories are powerful research resources. It means Dr Clarke can use the digitised cellular information from melanoma cases in the Leeds area and use it to 'train' an AI system to spot the signs of cancer from images of tissues samples.

And there is an added bonus. The AI system will be able to observe patterns across all the slides it interrogates, and through that it may be able to identify new bio-markers for disease.

Dr Clarke said: "There is a recognition that AI may be able to find patterns in vast quantities of data that humans cannot. There is little doubt that AI will be at the heart of future scientific development."

The full list of the UKRI AI CDTs

1. *Foundational AI* – UCL
2. *AI-enabled Healthcare Systems* – UCL
3. *Environmental Intelligence: Data Science and AI for Sustainable Futures* – University of Exeter
4. *Natural Language Processing* – University of Edinburgh
5. *AI and Music* – Queen Mary University of London
6. *Speech and Language Technologies and their Applications* – University of Sheffield
7. *AI for Healthcare* – Imperial College London
8. *Accountable, Responsible and Transparent AI* – University of Bath
9. *AI, Machine Learning and Advanced Computing* – Swansea University
10. *Machine Intelligence for Nano-electronic Devices and Systems* – University of Southampton
11. *Biomedical AI* – University of Edinburgh
12. *Social Intelligent Artificial Agents* – University of Glasgow
13. *Interactive AI* – University of Bristol
14. *Application of AI to the study of Environmental Risks* – University of Cambridge
15. *Safe and Trusted AI* – King's College London
16. *AI for Medical Diagnosis and Care* – University of Leeds

THE FUTURE OF MINDS AND MACHINES

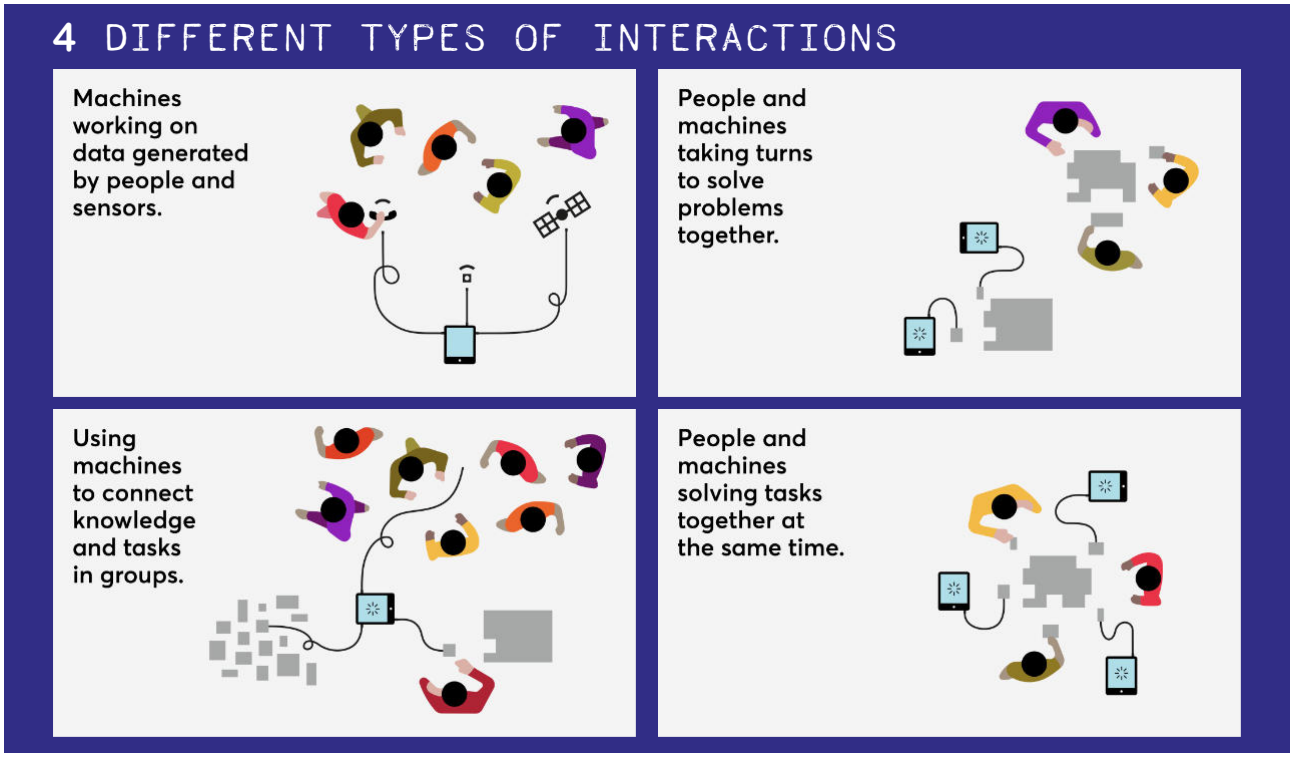
How artificial intelligence can enhance collective intelligence and help better prepare for the next big global challenges.

COVID-19 has shined a light on the added value and limits of the current capability for AI. Machine learning drove advances in the search for treatments and vaccines, while modelling was used to anticipate the impact of policy interventions.

On the frontline, the brightest light shone on the interconnected networks of people dealing with the challenges caused by the pandemic. These networks demonstrated a democratic approach to problem solving that we call ***collective intelligence***, or the enhanced capacity that is created when groups of people work together to mobilise a wider diversity of skills, insights and ideas.

Over the last 20 years, digital technologies have helped to harness collective intelligence (CI) at scale. Yet, despite these advances in citizen-led problem solving, we're still a long way from making the most of our collective efforts - but AI can help. »

Aleks Berditchevska
Centre for Collective Intelligence Design, Nesta



The four types of interactions between AI and human groups helps decision makers and innovators to navigate this nascent field.

HOW AI IS HELPING TO ENHANCE COLLECTIVE HUMAN INTELLIGENCE

Understanding how AI can advance human efforts to solve complex problems is at the heart of Nesta's vision for a public interest AI. Our report, *The Future of Minds and Machines*, first drew attention to the need for more imagination when it comes to combining AI and CI in practice.

Our case study analysis found that most examples applied a fairly narrow range of AI methods to crowd-generated content. Almost all of these methods relied on big datasets and supervised machine-learning techniques to extract meaning from unstructured digital data of human activity.

These applications demonstrated the added value of AI when it comes to improvements to the efficiency and scale of data processing, helping to make the most of collective inputs created through methods like crowd sourcing or citizen science. For example, Dataminr has built an AI-enabled emergency response tool that processes online text and images from social media posted by witnesses of extreme weather events like floods and hurricanes to generate early warnings. They're now working with the UN to help their humanitarian action teams coordinate the most effective response to crises anywhere in the world, targeting their support where they're most needed.

Our research showed only a few examples that applied emerging AI techniques or where algorithms were integrated into workflows in more creative ways. We found only a few lab-based experiments where AI was helping groups who were trying to solve problems together. In these cases, the added value of AI was about improving group interactions and outcomes by minimising the biases of individuals, or enabling groups to explore different options for complex issues. Our framework of the four types of interactions between AI and human groups helps decision makers and innovators to navigate this nascent field.

To help decision makers and innovators to navigate this nascent field we categorised interactions between AI and human groups into four types. *As outlined above.*

COLLECTIVE INTELLIGENCE AND PARTICIPATORY DESIGN OF AI

While the use of AI in CI initiatives is relatively new, CI-based methods have played a significant but often unrecognised role in shaping the development of AI; especially in machine learning approaches that rely on humans to label the large datasets they use as their training material. Increasingly we are seeing calls for more responsible research and development practices for AI technology to mitigate against potential harms - here, CI can also help.

Although the costs and potential negative impacts of AI throughout its lifecycle deserves careful attention, there is also a risk that these issues will overshadow the potential public benefits of the technology.

Collective intelligence offers another path towards an AI-enabled future.

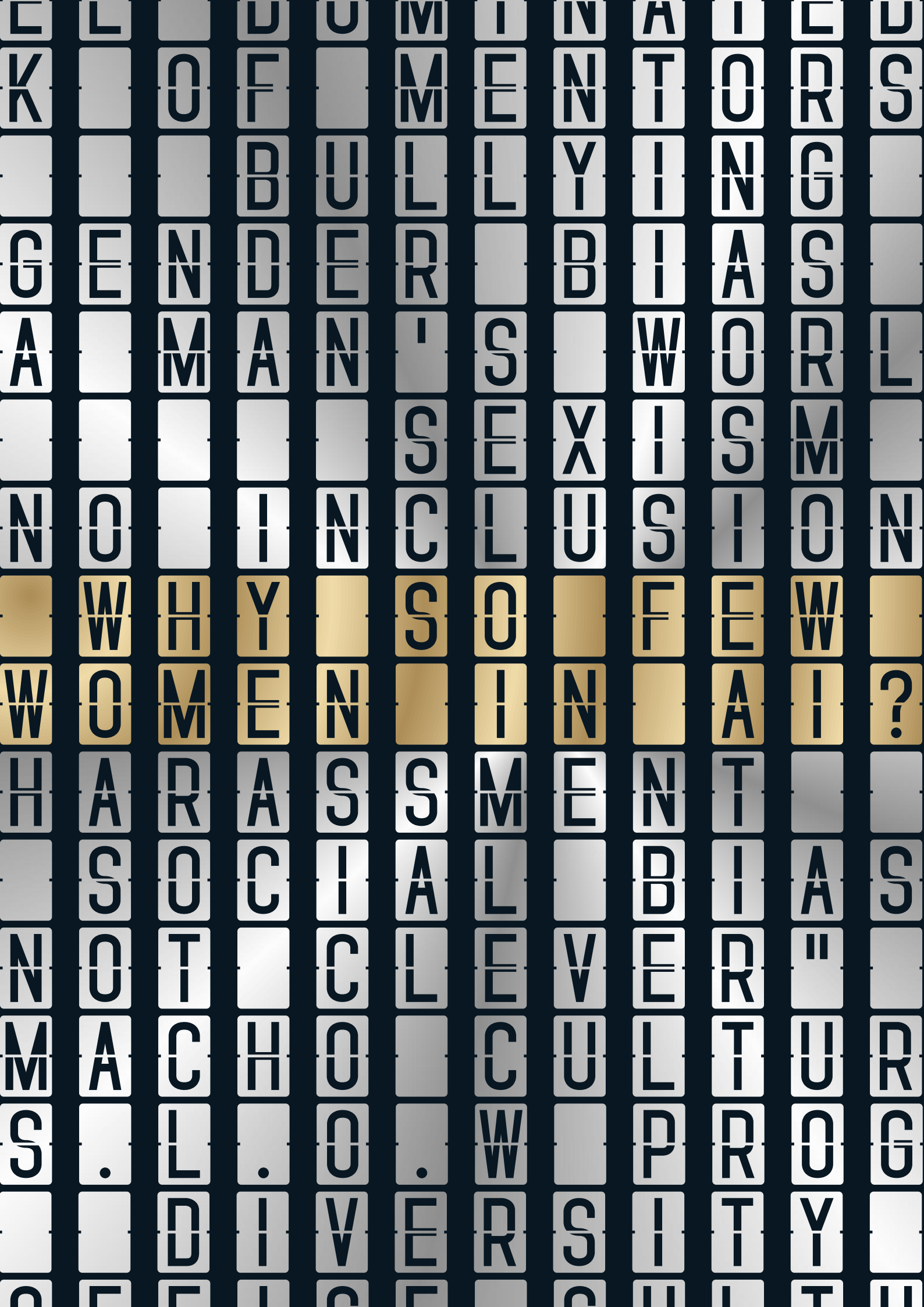
By getting more of us involved in questioning AI, scrutinising its impacts and imagining which problems we should be applying it to, we can move towards more values-driven deployment of smart machines. We call this participatory AI. Our current research investigates how participatory methods applied throughout the AI design and development pipeline affect the accuracy and impact of intelligent machines in real-world settings. It is part of an emerging field that is testing how to operationalise the principles for ethical AI practice.

Read the The Future of Minds and Machines report and find out more about Participatory AI at **nesta.org.uk/minds-and-machines**

AN ALTERNATIVE VISION FOR AN AI-ENABLED FUTURE

Our ongoing research into this field proposes an alternative trajectory for AI research and innovation, where AI is just one of the tools we use to enhance our collective ability to solve problems. To make these advances will require bold investment in (open and robust) public technical infrastructure, incentivising new fields of application and diverse AI techniques (beyond supervised machine learning), as well as embedding an experimentation and responsible innovation mindset into our approaches.

These actions would bring us closer to building the evidence base for how to best combine machine and human intelligence for real-world problems and put us in a better position to deal with the next global emergency whether it's related to health, the economy or the environment.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WHY SO FEW
WOMEN IN AI?
HARASSMENT
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MACHO CULTURE
S.L.O.W PROGRESS
DIVERSITY

Why so few women enter data science and AI professions?

There is a troubling and persistent absence of women employed in the AI and data science fields. This issue begins when, from a young age, girls can feel discouraged from pursuing STEM subjects. In 2012, the Organisation for Economic Co-operation and Development (OECD) surveyed the UK's 15-year old students and found that 41% of the girls agreed with the statement 'I am just not good at mathematics', while only 24% of the boys agreed with it. In 2015, the OECD surveyed the country's 15-year olds again and found that 4.6% of the boys expected to work as ICT professionals at age 30, while only 0.5% of the girls had the same expectations for themselves. Data-driven research can help us understand how biases in media coverage and public perceptions influence girls' lack of confidence in their own abilities, and explore how educational systems can discourage girls from engaging with mathematics and science.

Why, once they enter these professions, many women leave?

Women working in AI and data science in the tech sector have higher turnover and attrition rates than men. Like other studies, the Women in Data Science and AI project at The Alan Turing Institute has found that women spend more time than men in most industries apart from the technology / IT sector, where they spend almost a year and a half less (Young, Wajcman and Sprejer, 2021). Similarly, the US National Centre for Women and Information Technology found that women leave technology jobs at twice the rate of men (Ashcraft, McLain and Eger, 2016).

The 'chilly', unwelcoming climate of the tech workplace is a central contributor to the high attrition rates of women away from the data science and AI professions. This includes gender pay gaps, slow career progression for women, sexual harassment, male-dominated office culture and gender bias in hiring, all of which discourage women from continuing their careers in the fields.

Which interventions work to increase the number of women in data science and AI?

Existing research highlights that many popular interventions meant to increase diversity, such as diversity training or women-only conferences, are of limited effectiveness. Rather, successful models have been provided by the US universities Carnegie Mellon and Harvey Mudd, which have dramatically increased the participation of women in their computer science departments through strong commitment from senior management. For example, Carnegie Mellon increased the number of women from 7% in 1995 to 42% in 2000.

A key aim of the research we undertake in the Women in Data Science and AI project is to identify policy interventions that encourage more women to pursue data and AI careers. Recommendations thus far include the need for proactive steps to ensure the inclusion of women and marginalised groups in the design and development of machine learning and AI technologies, which includes disclosure and scrutiny of the current gender composition of companies' technical, management and applied research teams.

The ways in which the gender deficit shapes both the research agenda and the applications of digital technologies?

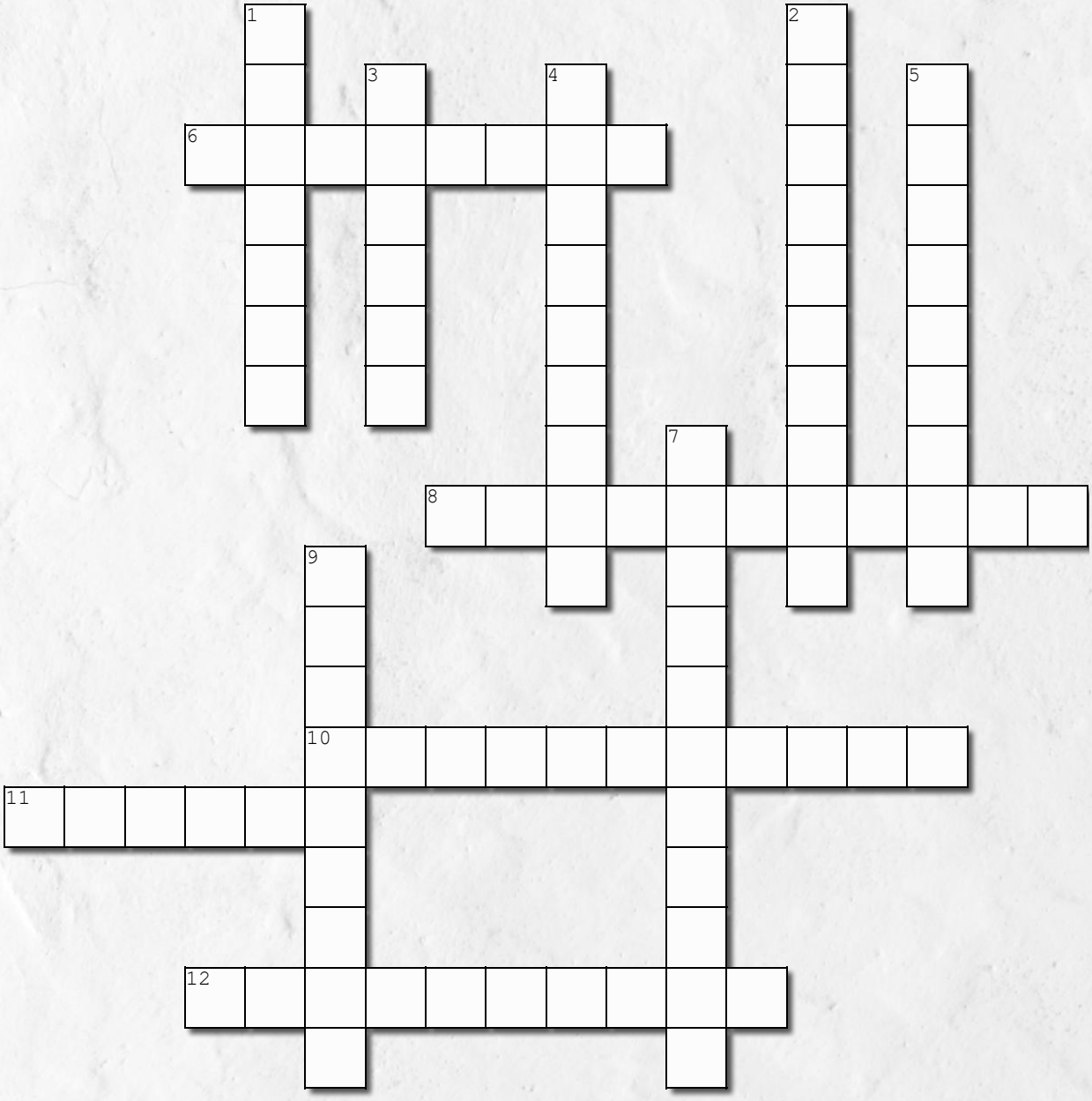
The under-representation of women and marginalised groups in data science and AI, alongside algorithmic and data biases such as the gender data gap, leads to the encoding and amplification of bias in technical products creating a dangerous feedback loop. A growing strand of research documents the fact that AI and machine learning systems can exhibit biases (e.g. Buolamwini and Gebru, 2018), and AI products are increasingly making headlines for their discriminatory outcomes. Growing women's participation is the only way to ensure that their perspectives and priorities will inform the insights that data scientists will generate, the AI systems that they will build, as well as the research agendas that they will define. It is crucial that we get ahead of this now, before flawed technologies become irreversibly integrated into the fabric of society.

The Women in Data Science and AI project within The Alan Turing Institute's public policy programme uses data science and social science research, looking through an intersectional lens, to inform policy measures aimed at increasing equality in the data and AI fields in the UK and globally. We work alongside policy-makers, offering actionable insights and recommendations to tackle the multifaceted ethical, economic and governance-related issues stemming from such inequalities.

Visit the dedicated **Women in Data Science and AI hub** at turing.ac.uk, and read the project's most recent policy paper *Where are the women? Mapping the gender job gap in AI*.

HARTREE CENTRE
CROSSWORD

Try to solve this crossword to understand how the Hartree Centre provides UK businesses with access to world leading facilities and expertise in advanced digital technologies, including supercomputing, data analytics and AI.



Answers on page 138

@HartreeCentre

Science and Technology Facilities Council

Hartree Centre

DOWN

1 The new Hartree National Centre for Digital Innovation - backed by £210m from UK Government funding - will enable businesses to acquire the skills, knowledge and technical capability required to adopt digital technologies like AI and _____ computing.

2 The Centre partnered with IBM Research and established agricultural research centre Rothamsted Research to understand soil health and how to improve it. Machine learning methods provided a detailed view of soil properties by analysing the _____.

3 Liverpool-based law firm Weightmans are using AI technologies to assist solicitors omitting sensitive information in legal documents faster and more cost-effectively without compromising on accuracy or security.

4 Hartree Centre is a 'Northern Powerhouse' for Innovation, based in _____, Cheshire.

5 By slashing run-times for even the most complex simulations from weeks to days or hours, the Hartree Centre helped Unilever to optimise the whole design process for this area.

7 Scotch Whisky Research Institute is using machine learning models to identify spectral regions of relevance in whisky samples, helping them to spot and pull _____ whisky from the black market.

9 The Centre partnered with Alder Hey Children's Hospital in _____ to develop an AI-powered chatbot that is helping to enhance the patient experience and reduce anxiety for children and families.

ACROSS

6 The Centre worked with AstraZeneca to optimise their chemical manufacturing processes, saving time and costs in large scale product production and manufacturing. This research used an advanced statistical solution called _____ Optimisation.

8 The P in HPC.

10 The branch of science and technology of Rolls-Royce's in-house design software, which was updated by the Centre, accelerating run times and bringing it a step closer to virtual 'whole-engine design'.

11 The Hartree Centre takes its name from Douglas Hartree (1897-1958), a mathematician and physicist. His middle name is _____.

12 As part of the ERDF-funded LCR 4.0 programme, the Centre helped car finance company BLOCKTRACK use this crypto currency wallet for greater increased transparency and assurance within its peer-to-peer car financing operations.

Could the Hartree Centre help your business enhance productivity with AI?
Find out at **hartree.stfc.ac.uk**

Pay Analytics for Inclusive Employers

Gapsquare

Gapsquare, based in Bristol, enables companies worldwide to track pay disparity, pay equality and pay gap data instantly and sustainably, building fairer workplaces and simpler processes around fair pay. Gapsquare offers AI insights around building an inclusive workplace and moving pay gap and equality analytics in-house and within the control of the company.

What challenges did Applied AI support Gapsquare to overcome?

The expert advice and knowledge provided allowed our team to utilise our unique skill sets even more effectively to support Gapsquare's growth. Since Applied AI, we've almost doubled the size of our team, and moved into working within new territories.

What inspired Gapsquare's mission to build a world where diverse talent thrives?

The World Economic Forum predicted a changing landscape of jobs where those in low paid roles, who largely tend to be women, will see a decrease in the opportunities available to them in the coming years if we do not start to change things now. At Gapsquare, we use AI technology to break down and analyse pay gaps in order to create a fairer future of work. Although our initial focus was on gender, we have now moved towards looking at the wider picture that also includes ethnicity, disability, sexual orientation and hybrid / flexible working.

What has been the team's most recent successes?

We are currently expanding into the European and US markets, the most recent example being our software integration with SAP. We've always been focused on client need, and made our software as intuitive and intelligent as possible based on what our users tell us they want. Most recently, that's looked like a new Workforce Planner, which will allow companies to plan and predict real-life pay equity scenarios, giving them clearer guidance and set goals to work towards fair pay within their organisations.

gapsquare.com

Combining climate science and AI to achieve a more sustainable and resilient world

Extreme weather events due to climate change cause damage worth billions of pounds every year. Iggy Bassi explains how Cervest is using AI to help organisations understand - and mitigate against - physical climate risks. »

Iggy Bassi
Founder & CEO, Cervest

"Acts of God" is how people throughout history have viewed extreme weather events such as droughts and storms. Indeed, when I was running a sustainable agribusiness in Ghana, local farmers I worked with seemed happy to write their increasingly volatile harvests down to divine intervention.

Fast forward to today, most businesses and governments are looking at the impact of climate on their assets in just the same way. They have no way of knowing what's at risk, from which climate phenomena, or when it is most likely to happen.

Whether you're a Ghanaian farmer, the CEO of a hotel chain, an insurer, investor or bank: getting ahead of the risks you face from climate change can enable you to plan with certainty, and thrive.

This thought gave me the idea of finding a means to make climate risks personalised and actionable for anyone. If we could take advanced climate science, and present it in ways that non-experts would find easy to understand and act on, we could transform how companies and people think about climate change. We have called this new capability Climate Intelligence.

Our early work with The Alan Turing Institute is a good example of machine learning helping make sense of highly fragmented data about our planet. The collaboration was based on the Turing's multiresolution machine learning algorithms, and Cervest's data engineering platform and machine learning algorithms — initially applied to crop yield forecasting and remote sensing data.
Photo credits: Cervest

A unique challenge

Empowering non-experts to understand and act on advanced climate science is far easier said than done: getting hold of good climate data is the easy part. The problem is, in its raw form, this data is very difficult for most people to make sense of.

There are very good reasons for this. The Earth's climate is a highly complex, interconnected system - where a shift in water temperature in one hemisphere can trigger flooding or drought in another. Building reliable data models that can predict its behaviour has taken decades of painstaking observation and analysis.

How does one translate data compiled by scientists into insights business users can act on? It is a non-trivial question - and finding the answer took us to some of the UK's foremost research organisations. We're discovering the answers in areas like Bayesian statistics, data science, and AI - all areas where UK research is at the cutting-edge.

Fortunately, two of the world's leading research institutions in these areas are on our doorstep in London: Imperial College and The Alan Turing Institute. We are collaborating closely with both organisations on applied research that is helping make Climate Intelligence a reality.

Our work with the Turing is a very good example of how machine learning can help us translate fragmented data about our planet into more meaningful and actionable insights. Together, we are developing machine learning models that combine low-resolution data from a variety of sources in order to build up much richer,

and more uniform, pictures of the Earth and atmosphere.

It's an area of machine learning known as Multiresolution Multitask Learning, in which different data models learn from one another as they complete tasks - constantly testing and retesting hypotheses until they arrive at a solution that works. The science is complex, but it enables us to build a detailed understanding of how climate models might predict events on the ground.

Driving lasting change

These new capabilities can do more than provide information on what's at risk. By opening Climate Intelligence up to everyone then we believe we can help catalyse lasting change.

For example, insurance coverage will become cheaper for assets with lower climate risks, while businesses will be able to scrutinise their suppliers' exposure. Unsustainable, risky practices can be brought to an end, and vulnerable communities shored up.

Bayesian statistics and Multiresolution Multitask Learning may not trip off the tongue, nor are you likely to come across them in day-to-day life. Nonetheless, these obscure areas of maths and data science are helping make climate change less about "acts of God", and focusing minds instead on achieving a more resilient, sustainable future for our planet.

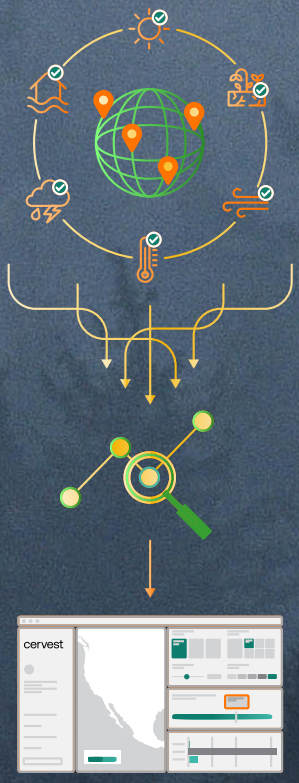
Learn more about Cervest's cutting-edge research with The Alan Turing Institute at **turing.ac.uk**

Cervest is a member of the Tech Nation Applied AI Alumni Network.

cervest.earth

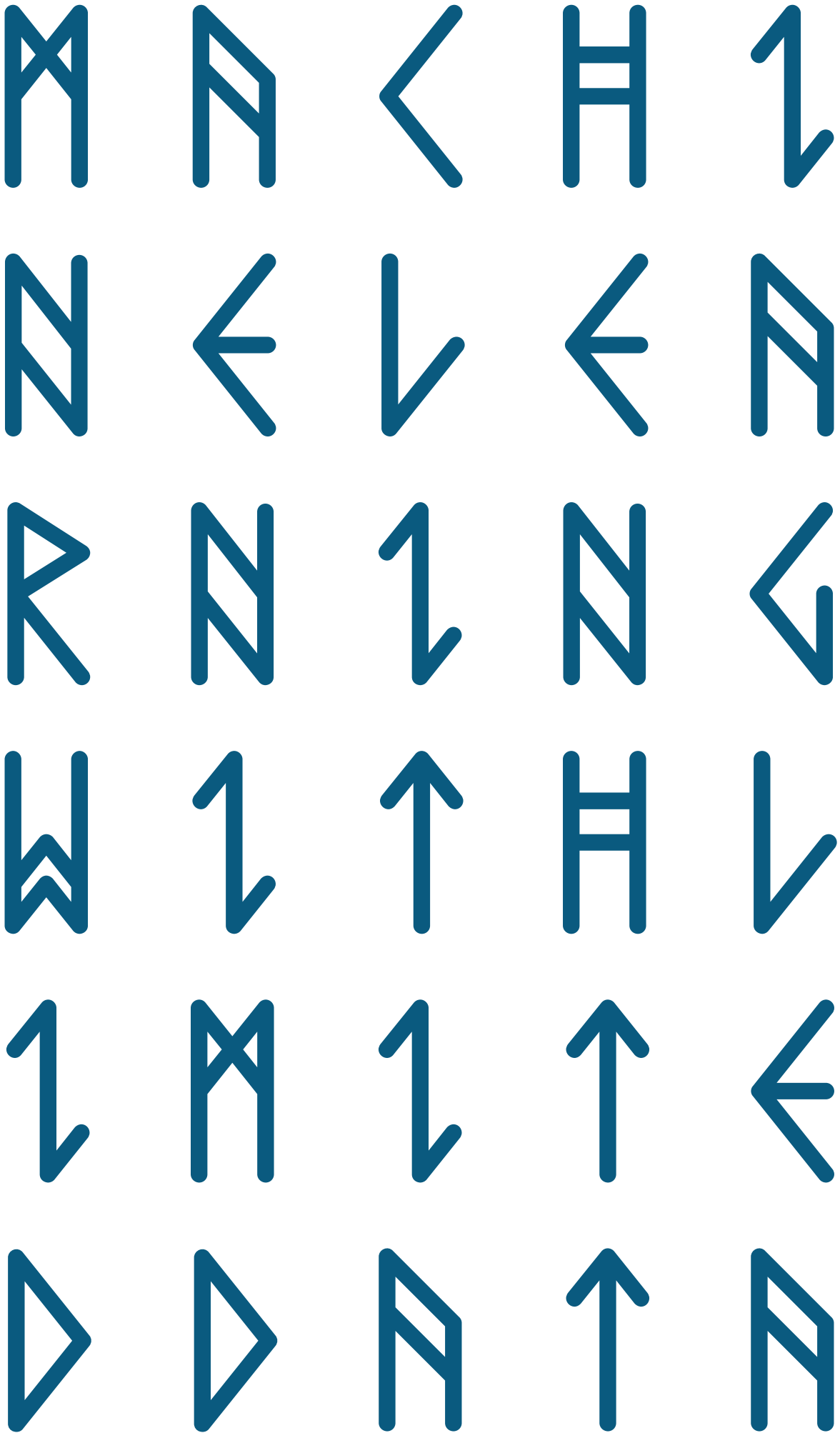
How AI helps deliver Climate Intelligence

There is a wealth of data on different aspects of the Earth's climate.



Cervest's Climate Intelligence platform translates this data to make it easy to understand.

The Climate Intelligence thus generated acts as a "single source of truth" for all stakeholders: from decision-makers to investors, regulators – even the general public.



[dstl]
The Science Inside

MACH_NE LEAR_ING _ITH L_MIT_D D_TA

Machine learning requires large amounts of data, but there are many problems where there is not sufficient labelled data available for training. Novel machine learning techniques are required to obtain the benefits of machine learning in these limited data problems.

Whether we realise it or not, machine learning touches many parts of our lives, from recommendations on Netflix or Amazon, to virtual assistants like Siri. These are all trained on the data of millions of daily users. Recent successes in machine learning have all been in areas where there is a large amount of labelled data for training, whether this is from user interactions or large-scale human labelling.

There are many scenarios in which machine learning could provide a significant benefit, but there is not a large enough dataset available to train a machine learning model. This is particularly the case in Defence and Security, where we are often interested in events or objects where there may only be a couple of known prior examples. In a search and rescue operation, we want to be able to identify a particular object from Unmanned Aerial Vehicle (UAV) imagery, even if we only have a few photographs to work from.

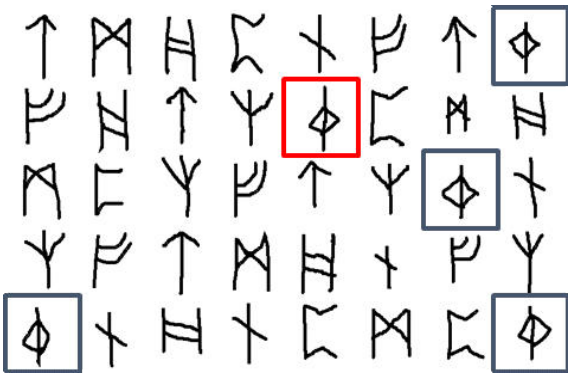
The other challenge we face in Defence and Security is that the labelling of data can be prohibitively expensive due to the sensitivity of the content and the skill required to analyse it. Instead we must make the most of the information in unlabelled datasets and limit the human labelling to the most informative examples. Minimising the labelling required will allow machine learning to be applied to a much wider range of problems.

> *"Actors able to acquire the best AI will have a significant advantage over those with less capable machine learning systems."*
>
> Joint Concept Note 1/18
> Human Machine Teaming 2018

Humans are very good at learning with limited data. As a baby, we are not provided explicitly labelled information to learn from and we learn by interacting with the world. Through our experience of interactions and our memory of prior examples, we are able to identify objects and events having seen them only a few times. This is a key strength of the thousands of analysts that the Ministry of Defence employs to identify such rare objects and events, but with the ever expanding volumes of information that is becoming available, analysts cannot do this alone and require support from automated agents, such as machine learning algorithms. »

Todd Robinson
Senior Data Scientist, Dstl: Defence Science and Technology Laboratory

We therefore require machine learning methods which can learn with only a limited amount of data, as humans do. Topics like *few-shot learning*, where a machine learning model is trained on fewer than 10 examples, have been an area of significant academic interest in recent years and great advances have been made. A team of scientists at the Defence Science and Technology Laboratory (Dstl), is carrying out innovative research to understand and develop a number of state-of-the-art techniques for machine learning with limited data.

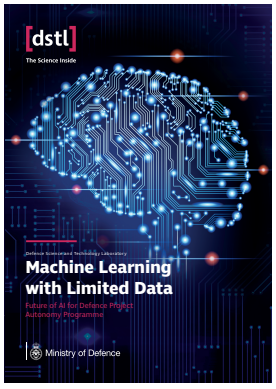


An example of the human ability to learn with limited data. Most people are able to identify all examples of a character in a previously unseen alphabet, in this case Anglo Saxon, with only one example (in red).
Image credit: Dstl

> *"Understanding how to train trustworthy machine learning systems with limited data is a critical challenge for many Defence applications where large amounts of training data might not be available. Overcoming this challenge will improve our ability to responsibly & safely apply this technology to a range Defence activities."*
>
> Prof. Steve Meers,
> AI Strategy Lead, Dstl

Limited data techniques can support search and rescue using UAV imagery, where we only have a few examples to learn from. *Photo credit: Ministry of Defence*

Based on some of our research, Dstl have published a handbook capturing some of the state-of-the-art approaches that should be considered when applying machine learning to a problem where the amount of training data is limited, and how mature these are.



Read the Dstl handbook **Machine Learning with Limited Data** at gov.uk/dstl

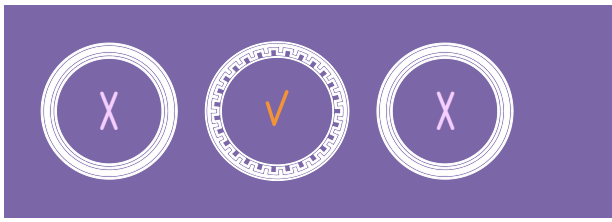
MOD analysts, such as this radar analyst on HMS Daring, are very effective at learning with limited data. With expanding volumes of information for analysis, analysts require machine support to identify rare objects and events.
Photo credit: Ministry of Defence

APPROACHES TO MACHINE LEARNING WITH LIMITED DATA

Small amount of data, mostly unlabelled

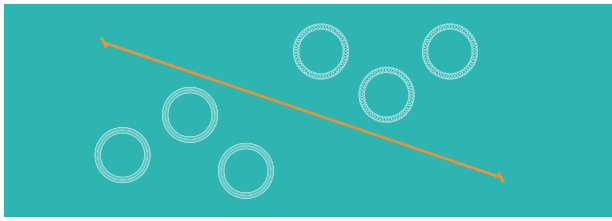
ZERO-SHOT LEARNING

Learning new classes with no examples, and instead using descriptions based on known attributes to train the model.



TRADITIONAL MACHINE LEARNING

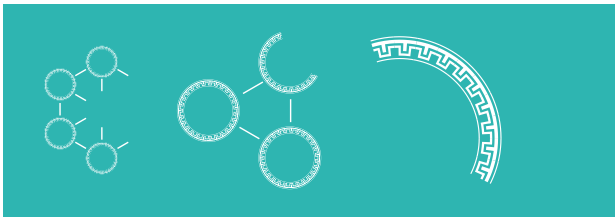
Non-deep learning techniques, such as decision trees, typically require less data for training, but achieve lower generality and accuracy.



Small amount of data, mostly labelled

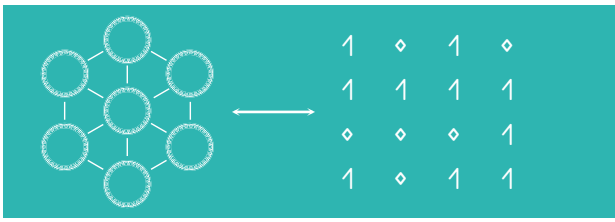
META-LEARNING

Learning how a machine learning model learns in order to train the model in the most effective way with only a few examples. **Few-shot** learning is a key meta-learning technique.



KNOWLEDGE ENHANCED MACHINE LEARNING

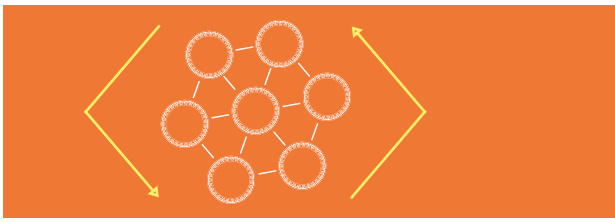
Using external, human defined, knowledge in machine learning models can reduce the knowledge needing to be learned from the data.



Large amount of data, mostly unlabelled

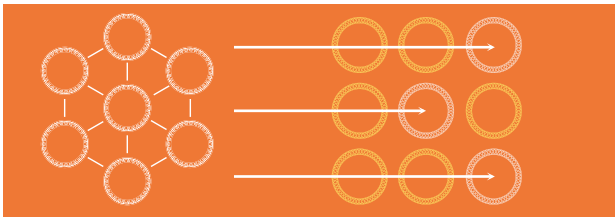
SELF-SUPERVISED LEARNING

Using a self-defined objective over a large unlabelled dataset to pre-train a model. This can result in higher accuracy than purely supervised pre-training.



ACTIVE LEARNING

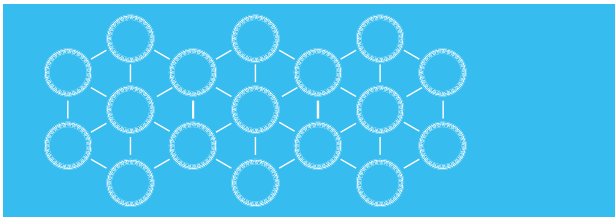
A training paradigm where the model selects the most informative examples for human labelling, reducing the amount of labelling required.



Large amount of data, mostly labelled

DEEP LEARNING

When there is a large amount of data with labels, standard deep learning approaches can be applied.



Quantum Ready

Quantum science involves harnessing the unique ways that light and matter behave at tiny atomic or subatomic levels. This science has already transformed people's lives by developing the building blocks of modern computers, the mobile phone, and the MRI scanner. It's now ushering a new era of quantum computers that could be much more powerful than current 'classical' computers and able to perform tasks that are practically impossible today.

Quantum computing (QC) and AI are both viewed as transformational technologies. QC is expected to accelerate tasks for AI, helping to support its further development.

The UK Government has long recognised the potential of QC and has committed £1 billion of public and private investment over 10 years (2014-24) through the National Quantum Technologies Programme (NQTP), which spans the areas of sensing, timing, imaging, communications and computing. The aim is to use the UK's strengths in quantum science and make the UK the go to place to research, invest and innovate in quantum technologies.

The potential is exciting, but the technology is still at an early stage, with many technological and engineering challenges to be overcome, thus necessitating a comprehensive programme of research, innovation, and training activities.

The economic potential of quantum computing

The availability of QC will impact many sectors, enabling improvements in efficiency, productivity and competitiveness as well as the creation of new products and services. Recent estimates indicate that $5-10 billion could be realised by technology providers and end users over the next 3-5 years, assuming the technology scales at the predicted pace. In the longer term, it's been estimated that QC has the potential to generate a value between $450 billion and $850 billion over the next 15-30 years, as we move towards practical, general-purpose quantum computers.[16]

What's a Qubit?

Perhaps we don't notice, but in the digital world our lives are ultimately encoded in 0s and 1s - the basic units of information, known as binary digits or 'bits'.

In the realm of quantum computing, information can be processed in the form of a quantum bit or 'qubit', which can exist either in a state uniquely as '0' or '1' or as a simultaneous combination of both '0' and '1', owing to a feature of quantum physics known as superposition.

A quantum processor can be constructed from multiple qubits, which can then be connected (or 'correlated') in a subtle and powerful way — this is called quantum entanglement. The combination of superposition and entanglement means that a quantum computer can process many inputs simultaneously.

This feature is crucial in enabling a quantum computer's power, allowing it to perform computations for tasks that are impossible for even the largest current supercomputers.

Driving the UK towards its quantum-ready ambition

The new **National Quantum Computer Centre (NQCC)** represents a flagship programme that complements prior investments in QC through the NQTP. The Centre will be headquartered in a brand new facility at the Harwell Campus in Oxfordshire, due to open in early 2023.

The Centre will bring together academia, businesses and the government to address key challenges to QC, such as scaling-up this technology, making it commercially viable and exploring how to create economic value. Working closely with industry and the research community, the Centre will also provide businesses and research institutions with access to quantum computers as they are developed around the world and grow the UK's thriving quantum computing industry.

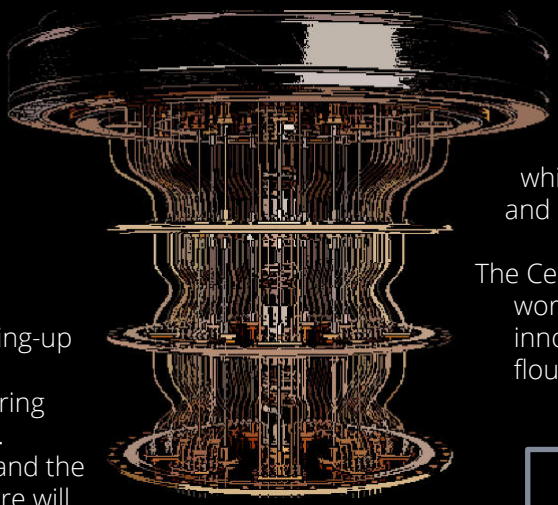


Illustration of a quantum computing system's interior

The NQCC will foster a vibrant environment that promotes collaboration between quantum hardware and software researchers, and attracts visitors and industry interest from across the UK and internationally. The mixed provision of office, meeting and laboratory spaces will enable multidisciplinary teams to collaborate, providing the necessary infrastructure and an environment in which to design, build, operate and host quantum computers.

The Centre will help ensure that world leading research and innovation continues to grow and flourish in the UK.

Learn more about the NQCC at **nqcc.ac.uk**

UKRI National Quantum Computing Centre

[16] Jean-François Bobier, Antoine Gourévitch, Matt Langione and Edward Tao (2021). *What Happens When 'If' Turns to 'When' in Quantum Computing?* BCG.

Recycleye

Spearheading the Green Revolution

Recycleye is training the world's most powerful machines to bring total transparency, traceability and accountability to the waste management industry. Their team of technologists and creatives has developed computer vision algorithms that replicate the power of human vision to identify every item in entire waste streams - broken down by material, object and even brand.

Recycleye's co-founders were named in Forbes 30 Under 30 for Social Impact. Congratulations! What piece of advice would you give to new founders thinking about joining Applied AI?

As founders, we have benefited from joining a community of growing entrepreneurs, where we have been able to overcome shared challenges together. The invaluable expertise provided by late stage founders from insight sessions provided us with the structure to build out Recycleye's early commercial strategy.

What inspired Victor and Peter to launch Recycleye?

While studying for his PhD at Imperial College London, Victor found the impact recycling facilities can have on a country's recycling rates has been hindered by the waste industry's reliance on manual labour to sort waste. The co-founders set out to improve the quantity and quality of materials recovered by leveraging cutting-edge technology to automate the recycling industry entirely. The company have developed Recycleye Vision, an AI computer vision system which replicates the power of human vision to identify all individual items in waste streams, and Recycleye Robotics, an intelligent robotic picker, to turn trash into treasure.

How has Recycleye grown since its inception?

In under 2 years, Recycleye has installed over 10 Recycleye systems across the UK and France, optimising the recycling facility operations of the largest waste management companies in Europe. Underpinned by WasteNet, the world's largest dataset of waste images, Recycleye Vision exceeds human performance in waste item identification. Now, the revolutionary team of 15 mission driven technologists have partnered with FANUC to deploy Recycleye Robotics, powered by Recycleye Vision, to eliminate manual picking entirely.

recycleye.com


EDINBURGH
UCL
EXETER
KING'S COLLEGE
CAMBRIDGE
WE'VE
PLACES
ALL OVER
PLACES
LEEDS
GLASGOW
BRISTOL
QUEEN MARY
IMPERIAL COLLEGE
SOUTHAMPTON
SWANSEA
BATH
UK Government
The first wave of a **1000 AI students across 16 Centres for Doctoral Training in AI** have started their PhDs thanks to a £100m investment from the Government matched by £100m cash and in-kind from project partners and universities
UKRI

ACHIEVEMENTS UNDER THE NEAR £1BN AI SECTOR DEAL (SO MANY, WE HAD TO PUT IT IN SMALL PRINT)

Creating an economy that harnesses AI and data is one of the great opportunities of our age. This AI Sector Deal - launched in April 2018 - was the first commitment from Government, industry and academia to realise this technology's potential, outlining a package of near £1 billion of support for the sector.

BUSINESS ENVIRONMENT

We established the AI Council, with Tabitha Goldstaub, Co-founder of CogX, as the AI Council Chair and Business Champion; Dame Wendy Hall as the Skills Champion for AI; and Demis Hassabis, CEO and co-founder of DeepMind, as the Advisor to the Office for AI.

The **AI Council published its AI Roadmap in January 2021**. The independent report provides recommendations to help the government's strategic direction on AI.

PEOPLE

To develop the right skills for the jobs of the future and to create the environment for AI development and deployment, we announced:

- **16 new UKRI AI Centres for Doctoral Training** at universities across the country, delivering 1,000 new PhDs over 5 years.
- **New prestigious Turing AI Fellowships** backed by £46 million of government funding, to retain, attract and develop top global AI research talent.
- **Industry-funding** for new AI Masters places.
- **Up to 2,500 places for data science and AI conversion courses**. This includes up to 1,000 government-funded scholarships.

INFRASTRUCTURE

To facilitate legal, fair, ethical and safe data sharing that is scalable and portable to stimulate AI technology innovation, we:

- Partnered with the Open Data Institute and Innovate UK on three 'Data Trusts' pilots, tackling illegal wildlife trade, reducing food waste, and improving public services in the Royal Borough of Greenwich, London.

INTERNATIONAL

- The **UK became a founding member of the Global Partnership on AI,** an international and multi-stakeholder initiative to guide the responsible development and use of AI, grounded in human rights, inclusion, diversity, innovation, and economic growth.
  - GPAI's four working groups will each focus on: data governance; responsible AI; commercialisation of AI; and the future of work.
  - Senior UK experts from industry and academia have joined the four working groups.
- The **UK and the US signed a Statement of Intent on Cooperation in AI Research and Development.**
  - The Statement of Intent outlines a joint commitment to the development of responsible AI technologies with the overall ambition to harness the energy of public and private partnerships, to enrich the AI R&D enterprise, enhance technology commercialisation and create value for our citizens.
  - The Statement will also establish a joint R&D working group to promote strengthened collaboration.
  - The UK and US are starting from strong foundations. The Engineering and Physical Sciences Research Council (ESPRC) alone is funding over 100 UK-US AI collaborations.

PLACE

Working closely with key clusters to provide the support needed for AI businesses to thrive, we:

- Commissioned GDS to deliver a comprehensive review of AI adoption in the public sector, and published an **A guide to using artificial intelligence in the public sector**.
- Published **Guidelines for AI procurement** in collaboration with the World Economic Forum Centre for the Fourth Industrial Revolution. These will inform and empower buyers in the public sector, helping them to evaluate suppliers, then confidently and responsibly procure AI technologies for the benefit of citizens.
- Published **Explaining decisions made with AI**. Co-badged guidance by the ICO and The Alan Turing Institute to give organisations practical advice to help explain the processes, services and decisions delivered or assisted by AI, to the individuals affected by them.
- Launched Tech Nation's Applied AI growth programme with 29 participating AI firms, from across the regions including Scotland and Wales.
    - After a successful first year we announced 32 firms who joined Applied AI 2.0, 44% were founded by women and 2/3 are based outside of London.
- Funded up to £100 million for five new Centres of Excellence for digital pathology and imaging, including radiology, using AI medical advances.
- Funded £30 million for the Bayes Centre in Edinburgh, a world-leading centre of data science and AI.
- Launched the new **AI Dynamic Purchasing System (DPS)**, a new procurement framework that offers public sector customers a direct route to AI services in an emerging market.
- Published the **Ethics, Transparency and Accountability Framework for Automated Decision-making**. A framework to guide the safe and ethical use of algorithms and automated systems for public sector organisations.

IDEAS

To support the adoption of AI across the public and private sectors, we have:

- Supported the development and delivery of the Early Diagnosis Mission - which is to use data, AI and innovation to transform prevention, early diagnosis and treatment of chronic diseases.
- Funded £3 million for three new research projects to investigate how businesses can make best use of AI in insurance and law as well as analysing consumer attitudes to AI.
- Announced up to £79 million for three new AI programmes to transform engineering, urban planning and healthcare.
- Announced £600,000 funding for UK-Korea Health Sciences collaboration to focus on better diagnosis of dementia through the use of AI.
- Funded 40 AI and data analytics projects, backed by £13 million in government investments to boost productivity and improve customer service.
- Development of a new research and design facility, the Centre for Industrial Digitisation, Robotics and Automation, as part of the £50 million Derry City and Strabane Region City Deal.
- Launched The Hartree® National Centre for Digital Innovation (HNCDI), a new AI and quantum computing centre in North West England. The Centre is backed by a £210 million investment from the government (£172 million over 5 years) and IBM (£38 million), supporting 60 new scientific jobs in the Liverpool City Region.

11-12 novembre 2021

2e Sommet du PMIA à Paris

PMIA / LE PARTENARIAT MONDIAL SUR L'INTELLIGENCE ARTIFICIELLE

@GPAI_PMIA

The Global Partnership on Artificial Intelligence (GPAI) is an international and multistakeholder initiative to guide the responsible development and use of AI, grounded in human rights, inclusion, diversity, innovation, and economic growth.

GPAI's members are Australia, Brazil, Canada, France, Germany, India, Italy, Japan, the Republic of Korea, Mexico, the Netherlands, New Zealand, Poland, Singapore, Slovenia, Spain, the United Kingdom, the United States and the European Union.

My favourite poem

Sana Khareghani, Head of Office for AI

Written over 50 years ago this poem from the counterculture age still feels relevant today.

At the surface, the poem brings hope from emerging technology and the promise of realms brought within reach.

After reflection a sense of uneasiness starts to grow, a fear of dependence, a fear of losing the things we know, a fear of change.

I think the author felt, like many of us do today, that technology is both exciting and a game changer.

As our dependence on technology grows our inner-monologue starts asking; how do we stay in control?

All Watched Over by Machines of Loving Grace

Richard Brautigan, 1967

I like to think
(and the sooner the better!)
of a cybernetic meadow
where mammals and computers
live together in mutually
programming harmony
like pure water
touching clear sky.

I like to think
(right now, please!)
of a cybernetic forest
filled with pines and electronics
where deer stroll peacefully
past computers
as if they were flowers
with spinning blossoms.

I like to think
(it has to be!)
of a cybernetic ecology
where we are free of our labors
and joined back to nature,
returned to our mammal
brothers and sisters,
and all watched over
by machines of loving grace.

Hartree Centre Crossword

Answers 1. Quantum, 2. Microbiome, 3. Redact, 4. Daresbury, 5. Packaging, 6. Bayesian, 7. Counterfeit, 8. Performance, 9. Liverpool, 10. Engineering, 11. Rayner, 12. Blockchain

Photos and artwork credit

5 things to know about data trusts

From left to right Freepik, Icongeek26, wanicon, and Monkik, all from flaticon.com

A is for algorithm

A Unknown author, muslimheritage.com; *E* Science Museum; *H* Freepik; *I* Ery Prihananto, Vecteezy.com; *K* Graphic Nehar, Vecteezy.com; *M* watchtaxinyc, Vecteezy.com; *N* funforyou7, Vecteezy.com; *O* DinosoftLabs, flaticon.com; *P* Ancientartonya, Vecteezy.com; *T* Freepik; *U* Vectors Market, flaticon.com; *W* Freepik; *X* photo3idea_studio, flaticon.com; *Z* Deutsches Museum

A front row seat to the cutting-edge in health and care

Pietro Jeng, Geoffrey Moffett

Achievements under the near £1bn AI Sector Deal

Mark K Jackson

Beware the Robot carrying a keyboard

Jack Atkinson

Combining climate science and AI to achieve a more sustainable and resilient world
Jay Mantri, Paul Gilmore

Tech Nation Applied AI

Archangel Imaging Archangel Imaging; *C the Signs* Vince Fleming; *CattleEye* Matteo di Lorio; *Logically* Charles Deluvio; *Recycleye* Recycleye; *Vector.ai* Diogo Hungria

Ten Tech Priorities

tunnelmotions from Vecteezy.com

The Industrious GPU…

Boke! font from Skep Studio

The people, things and goals that inspired my passion for AI

Going clockwise Kyle Dias, Queen Mary University of London, Science Museum, John Schnobrich, Niko Photos, Barbara Zandoval; And Freepik

SIN: A Science Supernetwork

Pixelbuddha

Published in September 2021
by the Office for Artificial Intelligence


"If it's not
diverse
then it's
unethical"
Dame Wendy Hall
UK Skills Champion for AI
Regius Professor of Computer Science,
University of Southampton
UK AI COUNCIL
The AI Council provides independent, expert advice to the UK Government. The Office for AI (a joint BEIS-DCMS unit) is secretariat to the AI Council.