Artificial Intelligence: the present and future of technology

SHOWCASING COLLABORATION:

Highlighting university-business collaborations to address human challenges through AI partnerships

Spring 2023
“Artificial Intelligence: the present and future of technology” is the National Centre for Universities and Business’ (NCUB) latest addition to our showcasing series where we highlight significant university-business collaborations. In this edition, we celebrate our members’ crucial work in developing artificial intelligence (AI) for the benefit of society and the economy.

Joe Marshall
Chief Executive, National Centre for Universities and Business

The UK's AI industry is thriving, employing more than 50,000 people and contributing £3.7 billion to the economy in 2022.1

AI has been exceptionally high profile in recent months. Global attention has been captured by the astonishingly rapid development of generative AI technologies such as ChatGPT and DALL-E. These technologies use machine learning algorithms to create a dizzying array of new content, from photorealistic images to essays, music and videos to poetry. While AI has been a concept for decades, the rate of change in the last few years – even months – is creating concerns about the impact these new technologies could have on society.

AI can gather and analyse huge datasets in minutes and produce written work, photography and music of similar quality to a human. ChatGPT4 has already fooled exam boards in the USA and passed UK essay standards, according to newspaper reports.2 However, as a machine, it cannot consider the legal or ethical consequences of its actions in the way a human could; it cannot “think” about the context of a situation or appreciate human emotion.

The Government recently published a white paper - AI regulation: a pro-innovation approach - unveils what it described as “a world-leading approach to innovation” that will “turbocharge growth”.3 The aim of the white paper is to enable the UK to be at the front of the pack in the global race to capture the societal and economic value of AI technologies through a ‘pro-innovation’ approach to regulation. However, to do that responsibly, its aim is to manage the societal risks that AI poses and build the trust of the public in the role that AI can play in our economy and society.

Beyond the headlines of ChatGPT, we see AI technologies being deployed to increase efficiency and productivity across sectors, to support healthcare professionals to diagnose and treat medical issues, and even to explore new ways for people to interact with cultural and heritage institutions.

Collaborations between universities, businesses and others are at the heart of these advances. These collaborations already combine the best knowledge of academia and industry to develop technology that supports society in tackling climate change and Net Zero, streamlining manufacturing processes and creating potentially life-saving healthcare.

This booklet shines a light on eight specific collaborations, showing the transformative impacts they are driving across industries and different parts of society. Through their diversity, they also demonstrate the limitless breadth of applications provided by AI technologies.

In its Spring Budget 2023, the Government allocated funding for quantum computing – harnessing the power to collect data and perform complex calculations – which is vital for future development of AI. The Chancellor also pledged money for a “sand box” to help trial faster approaches to bring cutting-edge products to market.

It is absolutely right that society asks difficult and challenging questions about the significant risks that aspects of AI technologies pose. But, as this booklet shows, there are many positive uses for AI and, if it is developed and used responsibly, it has enormous potential to improve lives, grow the economy and support responses to major societal challenges.

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1 UK unveils world leading approach to innovation in first artificial intelligence white paper to turbocharge growth - GOV.UK (www.gov.uk)
2 Student “passes university exam” with ChatGPT bot in 20 minutes | The Independent
3 UK unveils world leading approach to innovation in first artificial intelligence white paper to turbocharge growth - GOV.UK (www.gov.uk)
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SECTION 1

AI for a greener, more sustainable world

The greatest challenge facing the world is the impact of climate change. Humanity needs every tool at our disposal to reduce the environmental impact of economic activity and to monitor changes to the planet’s environment and ecology.

AI technologies have a role to play here – helping to design and implement more efficient processes, to decarbonise industry, while also improving the approaches to modelling and monitoring our environment.

In this section, we show collaborations that utilise AI technologies to improve the efficiency and longevity of machinery in manufacturing and improve the effectiveness of earth observation methods for ecology and environmental monitoring.
AI for a greener, more sustainable world

Revolutionising machinery maintenance

Condition monitoring of industrial machinery and power networks has become increasingly important for companies and utilities.

It helps them to reduce maintenance costs, minimise unplanned downtime and optimise asset performance. Advanced technologies such as interconnected devices, big data analytics and machine learning algorithms are being employed to collect and analyse real-time data from various sensors and measurement tools.

This means collecting data on factors such as temperature, vibration and power, which can then be analysed to identify trends and abnormalities that may indicate potential issues. Current approaches to condition monitoring of industrial machinery typically demand a significant amount of infrastructure and some older systems may not have the capacity to accommodate advanced monitoring technologies. Additionally, manual analysis of the gathered data can be time-consuming and prone to errors, further adding to the drawbacks of traditional methods.

VoltVision is one company that has been at the forefront of this trend. The company developed a modular “plug and play” solution that can be retrofitted on high voltage powered machinery, such as motors in conveyor systems, pumps, compressors and other production equipment. This adds smart and digitally integrated features to existing equipment and infrastructure. The added connectivity of machines is known as the Internet of Things (IoT), which is one of the main pillars of Industry 4.0 - the fourth industrial revolution. Raw power data from hard-to-access high voltage and medium voltage networks extracted in this manner contain critical indicators of an asset’s condition. Applying advanced analytics and machine learning algorithms to these data, VoltVision’s system can then accurately predict equipment failures and prescribe appropriate maintenance actions. This minimises the risk of unplanned downtime and reduces overall maintenance costs.

To further enhance the capabilities of their system, VoltVision partnered with the Department for Business, Energy and Industrial Strategy (BEIS), Science and Technology Facilities Council (STFC) and a multidisciplinary team at Brunel University London and the Brunel Centre for Artificial Intelligence: Social and Digital Innovation, led by Professor Tatiana Kalganova, to conduct a project aimed at understanding the unique patterns exhibited by faulty industrial motors. Data was collected from a test rig, designed and built at Brunel University London using VoltVision’s innovative V-CUBE technology.

The Brunel AI team then analysed these data in conjunction with available open-source data to identify specific signatures associated with various motor faults. These insights were then used to develop an advanced analytical approach that automates the condition monitoring process. The end-to-end system can detect anomalous behaviour in assets, identifying potential faults and their severity. It can provide continuous feedback to the team to schedule maintenance and prevent faults from worsening and affecting other parts of the machine. Most importantly, the recent findings demonstrate the current approach does not require study of individual motors on their behaviour; instead, the model is generalisable and works well on different motors.

Professor Kalganova said: “Extensive trials of this approach have been conducted at various companies worldwide, gathering positive feedback regarding the significant improvements in operational efficiency and reduction in maintenance costs achieved through its implementation, and highlighting if there is any anomalous behaviour in their systems.

“Leveraging advanced technologies, such as IoT, big data analytics and machine learning algorithms for condition monitoring, has become a crucial aspect for companies and utilities seeking to maximize the performance and longevity of their critical assets.”

Strategic partnerships with organisations such as VoltVision can help these businesses enhance their operational efficiency and achieve significant cost savings by streamlining their maintenance schedules. Moreover, the implementation of such solutions can also contribute towards meeting environmental, social and governance (ESG) goals by mitigating unnecessary inefficiencies in power systems.

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AI for a greener, more sustainable world

Eliminating cloud shadow impact on observation imagery

Earth observation imagery has many uses, from disaster assessment to urban analysis to military intelligence in peace operations.

Using satellite sources, aeroplanes or helicopters or, more recently drones, data is gathered, and AI used to support monitoring.

However, earth observation imagery can often be accompanied by cloud shadows, which can obstruct the data collected and lead to it being discarded or processed separately. This increases the time and cost of the data analysis exercise that enables the building of accurate predictive models for forestry and environmental monitoring.

Mathematical sciences academics at University of Southampton teamed up with specialist remote sensing technology provider 2Excel geo to remove the impact of cloud shadows from high-resolution Earth observation imagery.

The project will support 2Excel geo's development of a new application that supplies detailed airborne data to industries including agriculture, conservation, risk management, ecology, landscape management and water quality.

Southampton academics will use their expertise in numerical optimisation and quantitative remote sensing to develop a technique that will reliably and accurately remove the impact of cloud shadows from the imagery. This will reduce costs and improve product quality for 2Excel geo's customers.

Professor Jörg Fliege, Head of Operational Research within Mathematical Sciences, said: "2Excel geo was faced with a ‘best guess what's under the cloud cover’ challenge. Through the SPRINT programme, we're able to help them with this by offering image analysis, optimisation and high-performance computation."

"The University has one of the largest research groups in operational research in the country and our mathematical modelling expertise is a tremendous asset for this project."

Dr Chloe Barnes, Head of Remote Sensing at 2Excel geo, added: "As a provider of airborne remote sensing services, cloud cover and cloud shadow can be a real challenge. With an average of only nine days per year when there's no cloud cover, it can impact our data analysis.

"This SPRINT project has been developed to help us to remove the effects of cloud shadow to enhance our data collection capacity."

University of Southampton has one of the largest research groups in operational research in the country and our mathematical modelling expertise is a tremendous asset for this project.

Northampton-based 2Excel geo delivers bespoke remote sensing solutions with a focus on forestry, agriculture and the environment.

"Cloud shadow in images can result in the data being discarded or processed separately, increasing the time and cost of the overall analysis. This, in turn, makes it more difficult and expensive to build accurate predictive models for agriculture, forestry, ecology and landscape management. Timely analysis of data is also crucial in environmental monitoring, conservation, risk management, water quality observation and humanitarian relief. High-performance optimisation tools are all able to help in these efforts now."
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SECTION 2

AI for cultural and creative impact

AI technologies present a major opportunity to enrich and inform our creative industries, culture and heritage sector, and our understanding of the natural world.

In this section, we show three examples of collaborations between businesses, universities and other knowledge-based institutions that are harnessing the power of AI to enhance their work.

The first of these utilises AI to personalise screen media content for mass audiences. The second and third explore the role of AI in digitally cataloguing and drawing insights from museums and historical records around the world to improve our understanding of history and the natural world.
AI for cultural and creative impact

A new personalised experience for media viewers

The evolution of mass-media audio-visual content is shifting towards internet delivery, opening new possibilities for hyper-personalised experiences that can be delivered to mass audiences.

This innovative, user-centred approach has potential to disrupt the media landscape by directly engaging individuals at the heart of their experience, rather than dictating content through traditional ‘one-size-fits-all’ formats such as existing radio, TV and film. This will enable new forms of user-centred media experiences that dynamically adapt to the individual, their needs and interests, their location, the media content, and the story.

The UKRI AI4ME Prosperity Partnership, led by the BBC and the University of Surrey with Lancaster University and UK creative industry SMEs, is addressing the major technical and creative challenges to creating and delivering user-centred personalised audience experiences at scale.

The research team is creating advances in audio-visual AI for machine understanding of captured content that will enable the automatic transformation of captured 2D video streams to an object-based media (OBM) representation. This approach has parallels with the way video games work, bringing together data objects such as scenes, characters and user interactions and then rendering them as live images for the player to view. Another essential element is the need for research to solve the problems of delivering personalised experiences at scale. Audiences of millions accessing personalised media requires transformation of media processing and distribution into a distributed low-latency computation platform with flexible deployment of OBM and compute-intensive tasks across the network, so-called Render Engine Broadcasting (REB). Early demonstrations, using examples such as weather forecasts and news services, are being used to demonstrate the power of OBM and REB.

The ideas generated by the partnership need to land well with the media industry, so that means having to develop tooling for OBM that will allow adaptation of workflows and processes to support efficient production, delivery and personalisation of the media experience whilst maintaining the audience-perceived quality.

‘Object-based media’ (OBM) is commonly used to describe the representation of media content by a set of individual assets together with metadata describing their relationships and associations. At the point of consumption these objects can be assembled to create an overall user experience.

Render Engine Broadcasting (REB) is exploring ways to distribute and consume Object-Based Media experiences at scale and investigating how we broadcast live personalised AR experiences to millions of people.
The partnership enjoys the support of a variety of companies, large and small, who are interested in adopting and exploiting the potential of these exciting technologies. Partners are contributing real-world experience and use cases to influence aspects of the project, as well as having early sight of the research outputs. It is only by bringing the academic researchers together with the commercial organisations who will deploy and commercialise the ideas, that the project can achieve its ambitious aims.

Professor Adrian Hilton, from University of Surrey, said: “Instead of just broadcasting monolithic programmes that viewers or listeners consume in the same way, personalised media experiences would transmit all the components, plus supplements, which can be automatically assembled in ways to suit individual user interest and needs. "The flexibility provided by this technology allows the viewer to change the media they view, for example, changing the language, introducing information overlays, activating accessibility aids, changing the length of a programme without losing the narrative, and adapting the media to be age appropriate, are just some of the scenarios that we’re exploring.”

Only one year into the five-year project, the team has already used the BBC’s iPlayer to reveal how much audience behaviours are evolving, achieved significant progress in extracting 2D and 3D Audio-Visual Objects, explored OBM media tooling and developed a modular framework for delivering personalisation with rendering in the cloud.

The BBC, as a world-leading broadcaster, is ideally placed to lead this partnership thanks to its access to audiences, world-renowned programme archives and data for testing, and its track record for impartially bringing the industry together and leading standards development. The partnership will allow the BBC to create compelling personalised media experiences and AI-enabled storytelling for mass audiences.

University of Surrey’s Centre for Vision, Speech and Signal Processing (CVSSP) is a UK leader in the development of AI that can transform captured audio and visual content into media objects to enable the creation and production of customisable personalised media experiences.

Lancaster University’s expertise in software-defined networking is being deployed in the development of adaptive network distribution to deliver personalised experiences to millions of people whilst maintaining cost and energy efficiency.

This new Prosperity Partnership builds on a 20-year successful research collaboration between the University of Surrey’s CVSSP and the BBC who have pioneered broadcast technologies used worldwide, as well as long-standing research collaborations between the BBC and Lancaster University that have resulted in a variety of new technologies.
AI for cultural and creative impact

Capturing data from the natural world

A strength of AI is its ability to quickly handle large quantities of complex information and make sense of it. Museums across the world hold huge collections of specimens that need to be catalogued and managed.

A team of scientists from Cardiff University is using state-of-the-art techniques to automatically segment and capture information from specimens and perform important data quality improvement without the need of human input.

With more than 1.1 billion biological and geological specimens curated in natural history museums around the world, the digitisation of specimens (transforming physical information into a digital format) has become an increasingly important task.

A treasure trove of digital information is invaluable for scientists trying to model the past, present and future of organisms and our planet. It could be the key to tackling some of the biggest societal challenges the world faces today, from conserving biodiversity and tackling climate change to finding new ways to cope with emerging diseases like COVID-19.

The digitisation process also helps reduce the amount of manual handling of specimens, many of which are very delicate and prone to damage. Having suitable data and images available online can reduce the risk to the physical collection and protect specimens for future generations.

As part of the project, the Cardiff team worked with museums across Europe, including the Natural History Museum in London, to refine and validate these new methods.

They have now taken a step towards making this process cheaper and quicker by using a deep learning-based method for image segmentation. This means they can easily and automatically locate and bind different visual regions on images as diverse as microscope slides or herbarium sheets with a high degree of accuracy.

Automatic segmentation can be used to focus the capturing of information from specific regions of a slide or sheet, such as one or more of the labels on the slide. It can also help perform important quality control on the images to ensure that digital copies of specimens are as accurate as they can be.

“This new approach could transform our digitisation workflows,” said Laurence Livermore, Digital Programme Manager at the Natural History Museum in London.

“In the past, our digitisation has been limited by the rate at which we can manually check, extract and interpret data from our images. This new approach would allow us to scale up some of the slowest parts of our digitisation workflows and make crucial data more readily available to climate change and biodiversity researchers.”

The method has been trained and tested on thousands of images of microscope slides and herbarium sheets from different natural history collections, demonstrating the adaptability and flexibility of the system.

Included in the images is key information about the microscope slide or herbarium sheet, such as the specimen itself, labels, barcodes, colour charts and institution names.

Typically, once an image has been captured it then needs to be checked for quality control purposes and the information from the labels recorded – a process that is currently done manually, which can take up a lot of time and resource.

Lead author of the study, Professor Paul Rosin, from Cardiff University’s School of Computer Science and Informatics, said: “Previous attempts at image segmentation of microscope slides and herbarium sheets have been limited to images from just a single collection.

“Our work has drawn on the multiple partners in our large European project to create a dataset containing examples from multiple institutions and shows how well our artificial intelligence methods can be trained to process images from a wide range of collections.

“We're confident that this method could help improve the workflows of staff working with natural history collections to drastically speed up the process of digitisation in return for very little cost and resource.”
AI for cultural and creative impact

Technological changes through history

Changes in mechanisation and technology throughout the eighteenth and nineteenth centuries made a significant difference to the way people worked.

This is not unlike the changes being experienced in the workforce now with advances in AI and robotics.

As we move through the Fourth Industrial Revolution, the Living with Machines project, led by the British Library, is looking back at history and using modern technology to provide new insights into the human impact of the industrial revolution.

Combining digital archives with data science techniques, the project team is investigating the effects of mechanisation on society.

The project is a partnership between the British Library, the Alan Turing Institute and the Universities of Cambridge, East Anglia, Exeter, and Queen Mary University of London.

Living with Machines will generate new historical perspectives on the effects of the mechanisation of labour on the lives of ordinary people during the nineteenth century. The project will also support the wider academic and cultural heritage sector in using digital methods to answer historical questions.

Maja Maricevic, Project Co-Investigator and Head of Higher Education and Science at the British Library, said: "The central theme – the mechanisation of work practices – speaks directly to present debates about how society can accommodate the revolutionary consequences of AI and machine learning. Living with Machines uses research methods that combine technological innovation and human expertise to help us understand the evolving co-existence of human and machine."

The project will create new datasets, tools and code that can be reused and built upon in future projects. The work has also offered the opportunity to develop new software tools to help the digitisation process, analyse the quality of the Optical Character Recognition, develop copyright-aware data access infrastructure and much more. It aims to harness the combined power of massive digitised historical documents and computational analytical tools to examine the ways in which technology altered the very fabric of human existence on a previously unprecedented scale.

Living with Machines will lead the research and development of new ways to marshal the UK’s growing number of digitised historical texts and documents. The creation of innovative computational models, tools, code and infrastructure will be key to enabling new scholarly questions with new depths of inquiry. This will act as a catalyst for other research projects, encouraging them to export high performance computing and big data to new domains of research.

The project has digitised over half a million pages of historical newspapers, as well as press directories (which provide information about readership, places and dates of publication) and Ordnance Survey maps. Together with the newspapers already available digitally on the British Newspapers Archive, have made it possible to study the newspaper landscape of the 19th century. These papers are also used for historical research and as source documents for crowdsourced activities. This will help to advance public awareness of how digital research can enhance understanding of history.

Curators, data scientists, historians, geographers and computational linguists are working together to devise new methods in data science and AI to revolutionise the way historical sources are analysed. This will provide vital insight into the debates and discussions taking place in response to today’s digitally inspired revolutions.

Optical Character Recognition (OCR) converts printed texts into digital image files. It is a digital copier that uses automation to convert scanned documents into editable, shareable PDFs that are machine-readable.
The world faces a series of major healthcare challenges over the coming decades. Many countries are starting to feel the effects of an ageing population, with more people living with complex, multiple conditions that require fast diagnosis and treatment. The COVID-19 pandemic has also shone a spotlight on health security and potential future health threats.

AI technologies already have a transformative effect on healthcare, with huge untapped potential. In this section, we show examples of researchers in academia, industry and clinical settings working together and deploying AI to address a range of challenges, from accelerating the development of new drugs, to improving diagnostic techniques and designing replacement joints.
AI that could reduce the cost and speed-up the discovery of new medicines has been developed as part of a collaboration between researchers at the University of Sheffield and AstraZeneca.

The new technology, developed by Professor Haiping Lu and his PhD student Peizhen Bai from Sheffield’s Department of Computer Science, with Dr Filip Miljković and Dr Bino John from AstraZeneca.

The study demonstrates that the AI, called DrugBAN, can predict whether a candidate drug will interact with its intended target protein molecules inside the human body.

AI that can predict whether drugs will reach their intended targets already exists, but the technology developed by the researchers at Sheffield and AstraZeneca has greater accuracy and provide useful insights to help scientists understand how drugs engage with their protein partners at a molecular level, according to the team’s new paper published in Nature Machine Intelligence.

The technology has the potential to inform whether a drug will successfully engage with an intended cancer-related protein, or whether a candidate drug will bind to unintended targets in the body and lead to undesirable side-effects for patients.

The AI is trained to learn the substructures of proteins in the human body as well those of drug compounds. The technology then learns how these substructures can interact with each other, which it draws on to make predictions on how new medicines will likely behave.

Key to the AI’s design is how the model learns pairwise substructure interactions - the multiple interactions that can take place between substructures of drug compounds and proteins in the body. Most existing drug prediction AI on the market learn from whole representations of drugs and proteins, which do not capture their substructures and so provide less useful insights.

In the next stage of the AI’s development, the team plans to use more in-depth data on the structure of compounds and proteins to make the AI even more accurate.

Dr Bino John, Director of Data Science, Clinical Pharmacology and Safety Sciences (CPSS) at AstraZeneca, said: “A key novelty of DrugBAN is its reliance on a bilinear attention network that allows it to learn interactions from substructures of both drugs and their targets simultaneously. We have also made the source code freely available to the public, which hopefully will support more AI approaches that will continue to accelerate drug discovery.”

Drug discovery and development using traditional methods can be incredibly difficult, with lengthy development times and huge sums of money in expenditure. However, drug discovery processes have the potential to be significantly accelerated, with advances in AI and digital technology, researchers are finding new ways to pinpoint which proteins a drug may interact with in our body.

Nick Brown, Head of Imaging and Data Analytics in CPSS at AstraZeneca, said: “I am really excited to see this work, particularly because unlike other approaches, DrugBAN simultaneously learns from candidate drugs and their targets using a bilinear attention network, and is explicitly designed to generalise the problem.”

Professor Guy Brown, Head of the University of Sheffield’s Department of Computer Science, added: “Our research at Sheffield is strongly motivated by a desire to make a positive difference to people’s lives, and we see interaction with industry leaders such as AstraZeneca as crucial to that mission.

“This is exciting research which will hopefully allow significant advances in the design of therapeutics. The approach is also distinctive for its focus on interpretability, enabling human experts to benefit from insights generated by the AI system.”

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AI for healthier lives

Safer diagnosis through ground-breaking technology

With medical services facing unprecedented challenges, technology is providing critical assistance to enable the efficient and effective diagnosis and treatment of a range of health issues.

AI is extremely adept at collecting, combining and interpreting large data sets and it is now helping health practitioners to identify critical insights from patient data. The key task now is to leverage facilities like the National Robotarium’s new Laboratory for Robotic Assistive Living (LARA) to turn ground-breaking technology into practical health solutions.

Researchers from the University of Edinburgh and Heriot-Watt University are doing just that. Using the LARA as a realistic social care testbed, the team is developing AI and socially assistive robots to detect urinary tract infections (UTIs).

UTIs affect 150 million people worldwide annually, making it one of the most common types of infection. When diagnosed early, it can be treated with antibiotics. If left untreated, UTIs can lead to sepsis, kidney damage and even loss of life.

The team’s FEATHER project (Facilitating health and wellbeing by developing systems for early recognition of urinary tract infections) aims to reduce the number of serious adverse outcomes that can result from late or misdiagnosis of UTIs and reduce the amount of antibiotics that are prescribed while clinicians wait for lab results.

In current practice, diagnosis can be difficult and time-consuming, with lab analysis taking up to 48 hours. Early signs of a UTI can be challenging to recognise because symptoms vary according to age and existing health conditions. There is no single sign of infection but a variety of symptoms which may include pain, temperature, frequency of urination and changes in sleep patterns. UTIs are particularly difficult to diagnose in people receiving formal care, and there is significant antibiotic overtreatment in this group as clinicians wait for lab results to return.

The FEATHER team is working with two industry partners from the care sector to inform their work. Scotland’s national respite centre, Leuchie House, and Blackwood Homes and Care are providing user insights to help the researchers develop machine learning methods and interactions for socially assistive robots to support earlier detection of a potential infection and raise an alert for investigation by a clinician.
The project will gather continual data about the daily activities of individuals in their home via sensors that could help spot changes in behaviour or activity levels and trigger an interaction with a socially assistive robot.

The FEATHER platform will combine and analyse these data points to flag potential infection signs before an individual or carer is aware there is a problem. Behaviour changes could include a change in walking pace, delirium, kettle use and number of visits to the bathroom.

Professor Kia Nazarpour, project lead and Professor of Digital Health at the School of Informatics at University of Edinburgh, said: “This unique data platform will help individuals, carers and clinicians to recognise the signs of potential urinary tract infections far earlier, helping to prompt the investigations and medical tests needed. Earlier detection makes timely treatment possible, improving outcomes for patients, lowering the number of people presenting at A&E, and reducing costs to the NHS.

“We also believe it will help to minimise the amount of antibiotics that are necessarily prescribed as a cover while waiting for lab results. As the second most common reason for the prescription of antibiotics, the infection makes a significant contribution to the increasingly concerning problem of drug-resistant bacteria, and there is widespread advantage to society in implementing better diagnosis.”

Professor Lynne Baillie, lead for the National Robotarium on Human-Robot Interaction, Assistive Living and Health, said: “We hope this work will create an additional structured support mechanism for people who live independently. Studies show that there is a significant association between delirium and UTI in older adults and, while it is possible that carers will pick up these signs, we should not be relying on observations alone. We are working with stakeholders to co-design the robot interaction and data collection for the machine learning methods to better support longer and healthier independent living.

"Working sensitively and supportively with this vulnerable social group is of the utmost importance. By developing the technology in the new LARA lab at the National Robotarium, we are able to test it in a realistic social care setting."

The human touch will remain an integral part of healthcare. Fortunately, research into AI capabilities like the FEATHER project are contributing vital tools to help practitioners create positive outcomes for their patients.
Creating the prosthetics of the future with generative design

Osteoarthritis (OA) is a significant source of chronic pain and disability, affecting approximately 15% of the world’s population. Joint preserving surgeries can relieve pain and retain full movement, and this is an effective alternative solution to a total joint replacement.

Researchers at the School of Engineering, University of Birmingham are working to design implants that are specifically engineered to match the requirements of the patient, allowing a swifter return to full function and maintaining quality of life for as long as possible.

Traditionally used to develop aerospace and automotive parts, the team at Birmingham have employed generative design to produce a joint preserving knee implant that can treat OA in partnership with design software specialists Autodesk, Manufacturing Technology Centre (the UK National Centre for Additive Manufacturing) and University Hospitals Birmingham. Their recently published study is the first known application of generative design to a biomedical implantable device.

Generative design uses AI and machine learning to design parts optimal for their intended use. Lighter and stronger components in an aircraft or car increase fuel efficiency and lower CO2 emissions. In biomedical engineering, generative design can create mechanically specific implants that are tailored to the load they will bear. Lighter, less prominent and minimally invasive, enables the patient to heal quicker, with less complications, and be less likely to need revision surgery.

Currently, knee implants for the treatment of arthritis are manufactured in limited shapes and sizes. A “one-size-fits-all” approach to knee surgery to treat OA can result in complications and poor patient outcomes, primarily due to overengineered implants. As such, there has been limited adoption of such surgeries to treat OA to date.

‘An AI integrated design allows us to configure tailored surgical planning parameters and take person-specific biomechanical information into account, and synergistically combine it with the embedded manufacturing intelligence to model medical-grade titanium implants specific to each patient,’ says Sanjeevan Kanagalingam, Lead Researcher at University of Birmingham.

3D printing techniques are starting to make implants designed to an individual patient’s geometry, for example the shape of their bones, but this doesn’t consider the constraints imposed by surgical planning or the patient’s weight or activity levels. These are essential elements to understanding how a patient’s anatomy and a knee implant will interact, crucial to implant design and post-surgical rehabilitation.

The team has created a functional prototype using Autodesk’s software, including how much of the process can be automated. The next steps are to mechanically test the devices to see how much they bend and flex under loads. If successful, they will eventually move on to clinical testing.

“The combination of the academic, industrial and clinical knowledge of the team working on this project, and the vast design space offered by generative design, has yielded implant designs beyond anything seen before. Such an approach, noting the diversity of the project team, has enabled the development of a design process, which can take into account the many differences between patients, for example, the variation between average male and female body mass,” says Dr Lauren Thomas-Seale, Principal Investigator and Senior Lecturer, University of Birmingham.
Conclusion

This booklet demonstrates the many and varied uses for AI technologies.

They have a role to play across sectors, industries and society and will be important tools in helping to address the major societal challenges the world faces. This spans from climate change to health and wellbeing, alongside capturing the cultural and creative heritage of the world and transforming how we consume content and create knowledge in the future.

While there are risks, as with any transformative technology, well-designed, positive collaborations between universities, businesses and other knowledge-based institutions are uniquely placed to identify and then realise the societal and economic benefits of AI technologies.
'Artificial Intelligence: the present and future of technology' is the latest in the NCUB’s quarterly showcasing booklet. Each quarter we focus on a different theme and celebrate and share the excellence of our member collaborations.

In the past year we’ve highlighted the work of our members in forming relationships with international partners, furthering community wellbeing by enhancing the quality and sustainability of social care services and helping to meeting the world’s environmental pledges.

Find out more about the successes of these collaborations by reading these publications.

Hydrogen: a fuel for the future (Winter 2022)
Partnering for positive change (Summer 2022)
International interactions (Spring 2022)

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For more information please contact NCUB at:

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