



University of  
**Nottingham**

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**Collaborative  
research in  
the School of  
Computer Science:  
Making a difference**

**Summer 2020**

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# Introduction from Head of School



**Professor Jon Garibaldi**  
Head of School

**The School of Computer Science is based within the Faculty of Science at the University of Nottingham, housed within the award-winning and internationally praised Jubilee Campus, opened by Her Majesty the Queen in 1999.**

As an international centre for excellence for computer science research and teaching, it provides state-of-the-art facilities and undertakes internationally leading collaborative research, attracting funding from across the globe. We are experts in a wide range of areas including user experience design, image analysis, virtual reality, artificial intelligence, computational modelling, functional programming, computational optimisation and data science.

Highly interdisciplinary, with leading academic collaborations across all faculties within the University of Nottingham, the school was ranked as a Top 10 UK computer science department for research power and second in the UK for research environment in the last Research Excellence Framework (REF) exercise.

We work with a wide range of organisations across various disciplines and sectors to collaborate on research projects and knowledge exchange.

Over the past five years the school has demonstrated significant positive growth, and attracted in excess of £20 million of research grant funding annually. With more than 85 academic and research staff members, the school has evolved to become an agile, flexible and responsive research entity, with the capabilities and expertise to lead and collaborate in international pioneering research that delivers positive impact for society across the globe. The school also benefits from the experience of 24 dedicated technical, managerial and professional employees.

This booklet has been produced to showcase the wide breadth of interdisciplinary, collaborative and high quality research the school has carried out with industry partners, and the valuable contribution this has made to society and the economy, while addressing real-world global challenges.



# Achievements

**Athena  
SWAN  
Bronze Award**

**Top 10**  
Computer Science department  
in the UK for research power\*

More than  
**250**  
PhD theses  
completed

Ranked  
**2nd**  
in the UK for  
research  
environment\*



**85**  
academic and  
research staff  
members

Campuses  
and research  
labs in UK,  
China and  
Malaysia



Secured more than  
**£15m**  
of AI-centric research  
income in last five years

Computerphile  
YouTube  
channel: Over  
**1.6 million** subscribers



**24**  
technical, managerial  
and professional employees

More than  
**£2m**  
of KTP funding secured

\* Research Excellence Framework Exercise 2014 (REF2014)

# School vision

The school shares the University's strategic mission to empower staff and students to collaborate in learning and research in order to solve real-world problems and improve lives.

We continue to be involved in pioneering research and innovation including the University's Beacons of Excellence and interdisciplinary Global Research Themes, which are committed to tackling global challenges.

Performing well in the last Research Excellence Framework exercise, the school was classed as a Top 10 Computer Science Department in the UK for research power, and ranked second in the UK in terms of research environment.

We are an innovative and agile research entity, with the multidisciplinary expertise to work together across a wide range of global and national sectors, holding an ever-expanding portfolio of industry partners.

Society will continue to benefit from the development of artificial intelligence (AI) applications. The school aspires to further expand collaborative research with industry in the AI field, in order to drive forward Nottingham's profile as a centre for excellence in multidisciplinary AI research. Particular areas of focus will be on explainable, sustainable and responsible AI projects.

Continued fast-moving technological developments promise a future of cyber-physical systems. The school is both forward-thinking and responsive to these emerging challenges, and has commenced a programme of expansion in this area, including development of cyber-physical research labs.

Alongside this we continue to provide an environment that allows both staff and students to thrive and excel in their education, research and careers alike. Our culture strongly supports equality, diversity and inclusivity and actively encourages better representation throughout the staff and student base.

You can find out more about our research at [nottingham.ac.uk/computerscience/research](https://nottingham.ac.uk/computerscience/research)



# Research portfolio

Our research portfolio spans a diverse range of interdisciplinary areas, and has strong and expansive links with national and global industry.

Expertise from our research informs our teaching and is integrated into undergraduate, postgraduate and doctoral study.

## Expertise

Artificial intelligence

Cybersecurity

Human-computer interaction

Intelligent and autonomous agents

Intelligent computational optimisation

Virtual and mixed reality

User experience design

Data science

Computer vision

Machine learning

Responsible research and innovation

Conceptual programming

Theoretical and foundational research

Smart products

Ubiquitous and mobile technology

## Sectors

Aerospace

Biomedical

Business operations

Creative and cultural industries

Engineering

Food and agriculture

Government and policy

Healthcare and medicine

Transport and mobility

Logistics

Manufacturing

Neuroscience

Retail

Energy

Finance

# Research collaborations and funding

The school works with a wide range of commercial, public and third-sector partner entities in order to tackle industrial and societal challenges.

Collaborations include large-scale international research projects, knowledge transfer partnerships, doctoral research, sponsorship of events, internship and work placements, hackathons, invited speaker seminars and sprint projects.

Examples of organisations and research funders include:

## UK Research Councils

- Arts and Humanities Research Council
- Biotechnology and Biological Sciences Research Council
- Economic and Social Research Council
- Engineering and Physical Sciences Research Council
- Medical Research Council
- UK Research and Innovation

## Europe and international

- Advanced Research Projects Agency – US Department of Energy
- Alzheimers Europe
- Defense Advanced Research Project Agency – US Department of Defense
- European Commission
- Bill and Melinda Gates Foundation
- National Natural Science Foundation of China

## Industrial collaborations

- Adobe
- BBC
- Brain+
- BT
- Capital One
- E.ON
- Experian
- Ford
- GE Aviation
- GlaxoSmithKline
- Gleeds
- Google
- GTT Communications
- IBM
- London Heathrow Airport
- Microlise
- Microsoft Research
- NATS
- Netacea Ltd
- Optrak
- Ordnance Survey
- Scottish Power
- Syngenta
- Telefónica
- Unilever
- YouTube

## Government, agencies, academies and trusts

- British Council
- Department for Digital Culture Media and Sport
- Health Data Research UK
- Innovate UK
- Leverhulme Trust
- Rail Safety and Standards Board
- Royal Society
- The Catapult Network
- The Institute of Coding
- UK Cabinet Office
- UK Clinical Research Collaboration
- Wellcome Trust





# Doctoral research

**The school has an outstanding track record in interdisciplinary doctoral training. More than 200 PhD degrees have been awarded to computer science research students, and we attract the highest calibre of students from across the globe to our PhD programmes.**

We have been successful in securing EPSRC funding for Industrial CASE Studentships, which has facilitated collaboration and sponsorship from organisations such as the BBC and GE Aviation. The EPSRC Horizon Centre for Doctoral Training (CDT) secured its third iteration of funding from the UKRI to continue to recruit students for the 'Creating our Lives in Data' theme. As of spring 2020, this multidisciplinary CDT has already produced more than 65 PhD graduates.

In 2020 we are planning for the recruitment for the first cohort of students for the multidisciplinary Nottingham Doctoral Training Centre in Artificial intelligence.

## EPSRC Horizon Centre for Doctoral Training – Creating our Lives in Data

This highly multidisciplinary CDT is based at the University of Nottingham and is supported by a multi-million pound investment from UK Research and Innovation, the University of Nottingham and over 50 industry partners.

The CDT focuses on digital identity, personal data and data creativity within the global digital economy, and is affiliated with the Horizon Digital Economy Research Institute. Each PhD student is paired with an industry partner to carry out collaborative research and completes an industry based internship. Examples of industry partners include Unilever, GSK, BBC, DTSL, RSSB, Ordnance Survey and Capital One.

You can find out more about the CDT's research at [cdt.horizon.ac.uk](http://cdt.horizon.ac.uk)

Doctoral students within the school have access to various internal and external funding mechanisms in order to accelerate the impact of their research and to transfer knowledge for the benefit of society.

PhD students within the school have secured funding and awards from the following sources:

- EPSRC Doctoral Prizes
- EPSRC Impact Acceleration Account Knowledge Transfer Grants
- EPSRC Telling Tales of Engagement Competition
- External industry partners such as Syngenta and Unilever
- Ingenuity Prizes – Nottingham University Business School
- Innovate UK Knowledge Transfer Partnerships
- Young Entrepreneurs Scheme

## Career destinations

International employment destinations of our doctoral alumni include academia, industry, start-up companies, government agencies and the private sector. Many have remained at the University of Nottingham and have progressed within an academic and research career, and are now supervising current doctoral students.

Examples of alumni career destinations within industry include:

- United Nations
- Airbus
- Jaguar Land Rover
- Sony
- Facebook
- Thales
- BBC
- Microsoft Research
- Johnson & Johnson
- German Aerospace Center
- Deloitte

# Case studies

The following case studies provide examples of collaborative research and knowledge transfer projects that have been undertaken, and showcase some of the different ways we have collaborated with industry.

- Intelligent optimisation through Innovate UK Knowledge Transfer Partnerships
- Pioneering computer vision tools lead to improved infant care
- Using deep machine learning to solve global biotechnology and plant science challenges
- Scanning the horizon: Addressing challenges and trust in the digital economy
- Human computer interaction: Creating interactive technologies to enhance everyday life
- Airport algorithm leads to flight departure efficiencies at Heathrow
- Collaboration in the spotlight: BBC Research and Development
- Beacons of Excellence: Solving today's global challenges
- Spinning out and starting up
- Celebrating women in science

# Intelligent optimisation through Knowledge Transfer Partnerships

Professor Dario Landa Silva – Computational Optimisation and Learning Lab



**Innovate UK Knowledge Transfer Partnerships (KTPs) help UK businesses to secure additional funding to innovate and grow, by partnering with an academic research organisation and a graduate. A KTP enables non-academic organisations to bring in new skills, benefit from the latest academic thinking, and deliver a specific strategic innovation project through a knowledge-based partnership.**

The school has been successful in securing external KTP investment for well over a decade, leading to collaborations and award-winning knowledge transfer projects with industry.

Professor Dario Landa Silva, Head of the Computational Optimisation and Learning Lab, has significant expertise in leading KTP projects within the school which have helped solve real-world industrial challenges. Details of the projects led by Dario, which have collectively secured funding of over £1 million, are provided below:

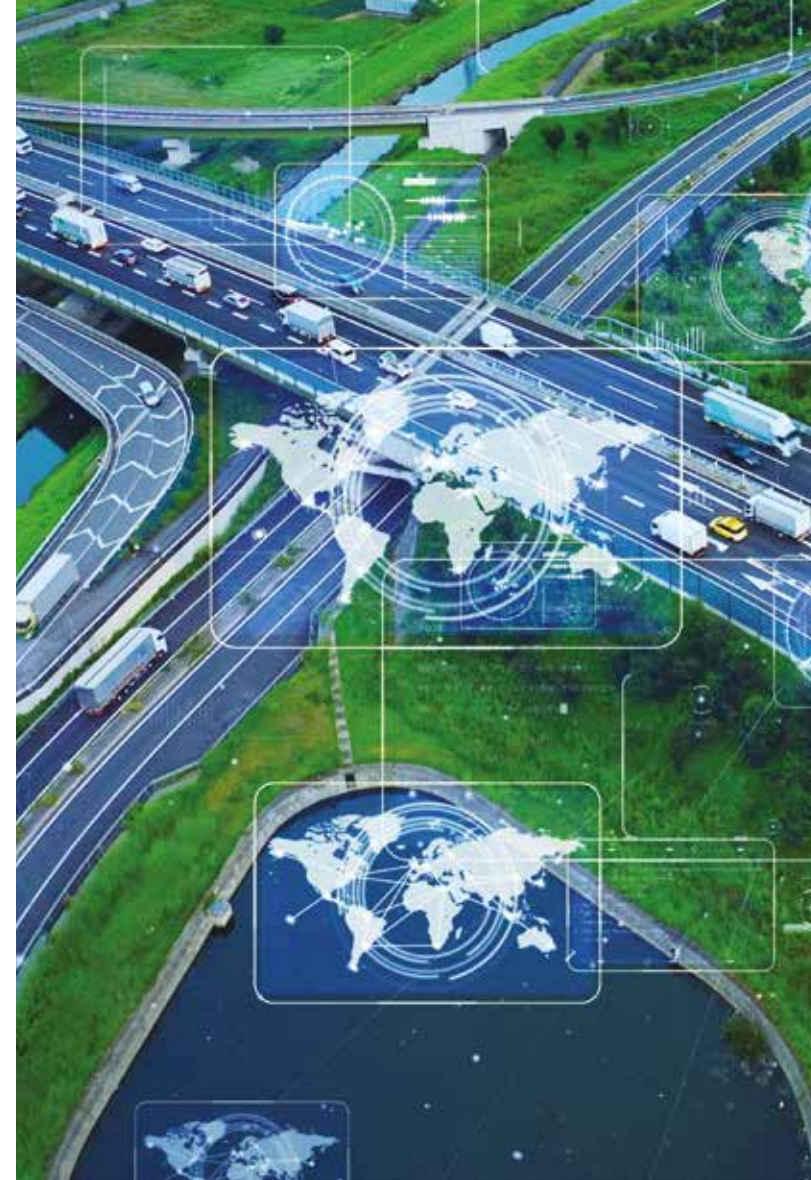
Project title	KTP partner	Project duration
Developing next generation rostering software using advanced scheduling techniques	MidlandHR	24 months
Design, develop and implement modern heuristic algorithms for improved adaptive carrier management and strategic scheduling	3T Logistics	24 months
Predictive and prescriptive analytics with optimisation for business intelligence	PXtech Limited	34 months
Improve homecare workforce utilisation by developing an adaptable software optimisation engine that solves rostering and routing workforce management scenarios	Webroster.net	24 months
Plan, develop and implement a telematics-based predictive maintenance system for commercial vehicles	Microlise	24 months

“The KTP opened a doorway into a tier of competitive technology that would otherwise have been a difficult step for our business to take. The opportunities it provided for future collaboration with academia and research is exciting for our ongoing competitiveness and growth”

Richard Dorf, CEO, PXtech Ltd

“In addition to knowledge transfer, KTPs are an excellent mechanism to forge new research directions and to realise impact”

Dario Landa Silva,  
School of Computer Science



## Collaborative Research and Development project spotlight: Innovative location-based services in collaboration with Microlise

Dario led on the **Collaborative Optimisation in a Shared-Logistics Environment (COSLE) research and development project**, with fleet management company Microlise. This project involved bringing together an array of data sets into a single environment in order to solve shared transportation logistics challenges. These large and busy data sets incorporated a combination of location, environmental, GPS and vehicle telematics data.

This two-year project aimed to develop an innovative service to improve transport efficiencies and reduce carbon footprints for logistics firms, by reducing the number of empty freight runs. This was achieved through novel optimisation algorithms created by academics in the school at the University of Nottingham, combined with the use of image processing and mobile technologies. It sought to integrate various optimisation techniques into a framework that facilitated collaboration in a shared freight transport logistics environment with the overall goal of reducing empty mileage.

Following completion of this project, Microlise is now collaborating on a four-year PhD studentship project within the Horizon Centre for Doctoral Training, focusing on real-time data analytics and human factors for heavy goods vehicle drivers. They are also a member of the Horizon CDT Stakeholder Advisory Group.

As well as the spotlight on KTP projects led by Dario, we are proud of the recent success other school academics have achieved in securing the following KTP collaborative partnerships and funding:

Project objective	KTP partner	School academic	Project duration
Improve cloud application scaling by using novel automated positioning and load balancing techniques	GTT Communications	Dr Milena Radenkovic	Started October 2019
Develop advanced data analytics methodology to provide structured and risk-modelled cost forecasts of new construction and refurbishment projects	Gleeds Cost Management Ltd	Dr Graziela Figueredo	May 2019 – December 2022
Develop and implement novel and advanced, hyper-heuristics based routing technologies for standard and non-standard haulage markets	Optrak Distribution Software Ltd	Dr Ender Ozcan	May 2019 – April 2022
Enable and empower customers to transition from 'passive energy customers' into 'proactive energy customers' via big data science and optimisation within energy management systems	E.ON UK Ltd	Dr Isaac Triguero	February 2018 – November 2021
Develop the next generation scheduling and timetabling solutions using cutting edge techniques	EventMAP Ltd	Dr Ender Ozcan	December 2016 – July 2019



# Pioneering computer vision tools lead to improved infant health care

Dr Mercedes Torres Torres and Dr Joy Egede – Computer Vision Lab

Mercedes Torres Torres and Joy Egede are postdoctoral graduates of the School of Computer Science. Mercedes is a Transitional Assistant Professor after graduating from the Horizon CDT, and Joy is a Research Fellow who completed her PhD within the International Doctoral Innovation Centre. Both are now based within the Computer Vision Lab, carrying out multidisciplinary research within a medicine and healthcare context, using innovative machine learning, image analysis and processing techniques.

Two examples of research projects that Mercedes and Joy have collaborated on with experts from the neonatal medical profession are provided below:

## Babyface: Gestational age estimation tool

The Gestational Age Estimation project was funded by the Bill and Melinda Gates Foundation and brought together an interdisciplinary team of researchers in the Schools of Medicine and Computer Science.

The challenge was to develop a tool to accurately calculate the gestational age of newborn babies using digital imaging, with the idea of deploying said tool in countries that have little or no access to ultrasound scanners and trained personnel. We developed state-of-the-art deep learning algorithms that were able to accurately estimate the gestational age of newborns within days.

Within this project, the Babyface crowdsourcing smart phone app was developed, which was used by parents and guardians to upload photographs and anthropometric measures of their babies in order to collect new securely-stored data to help doctors estimate whether a baby was born prematurely.

Due to its potential international real-world impact on society, the project received coverage in the national and international press, including an article in The Guardian and an interview on BBC Radio Nottingham.

## Neonatal pain assessment tool

Joy had already completed her PhD research on automatic pain assessment for adults and neonates using face video, and in 2018 successfully secured internal impact funding from the University of Nottingham to work on developing new video-based pain assessment tools for newborns, in collaboration with the National Hospital in Nigeria.

This impact acceleration project built upon the progressive pain assessment techniques that emerged from Joy's doctoral research, and resulted in:

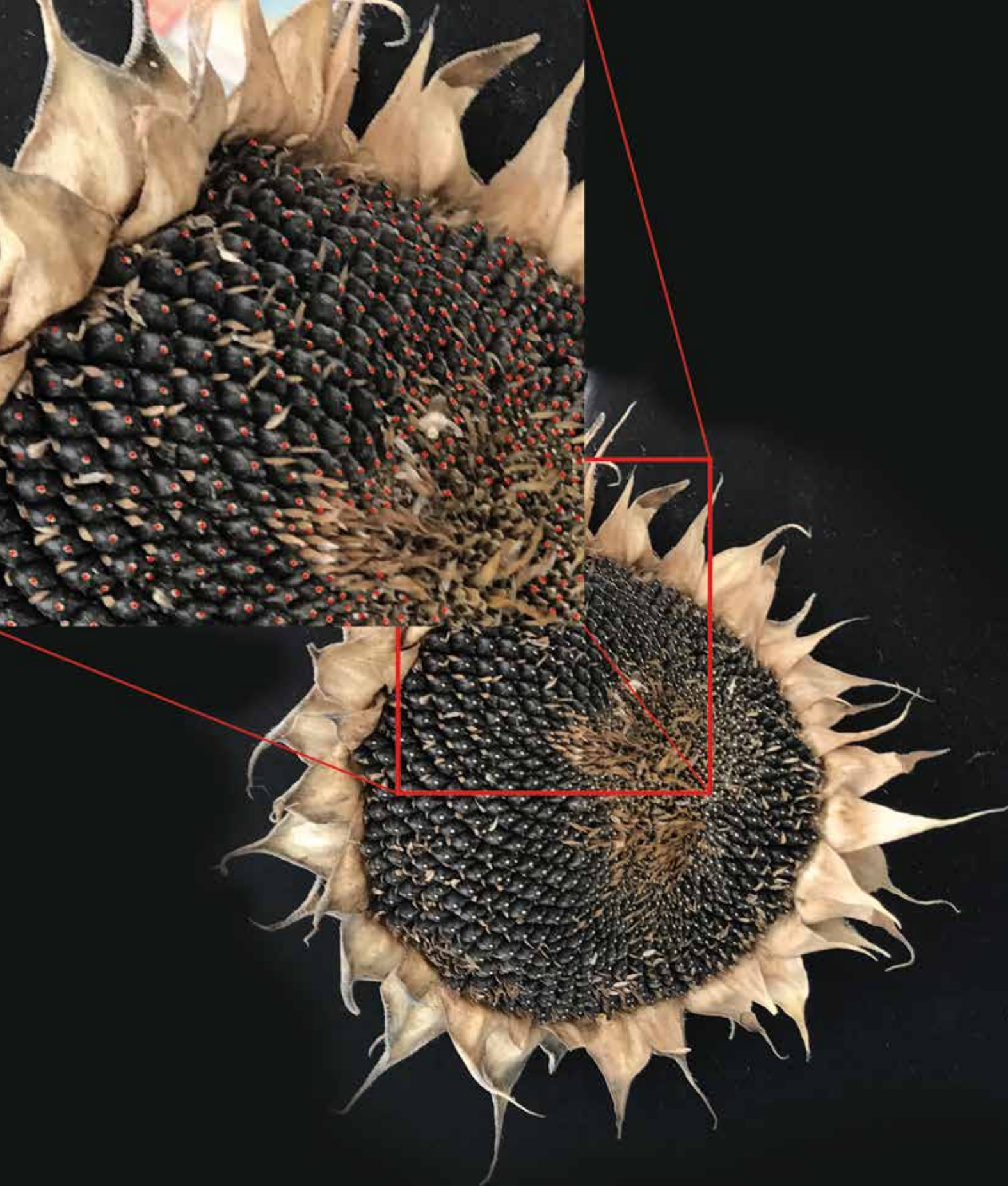
- the development of a new automated newborn pain assessment tool which produced results that were comparable to manual assessment by experienced Neonatal ICU nurses
- the creation of a new 11-point Neonatal Face and Limb Acute Pain Scale (NFLAPS), specifically suited for computer vision technologies
- the development of a new Acute Pain in Neonates database containing over 250 video recordings of various medical procedures and NFLAP pain annotations (scored by NICU nurses) for each video frame

Going forward the database will assist computer vision researchers in developing more efficient newborn pain assessment tools, consequently leading to improved infant care. Work continues to improve the performance of the model.

Joy (pictured below) is also an award-winning prize recipient from the 2020 L'Oréal-UNESCO For Women in Science UK & Ireland Rising Talent Programme.







## Using machine learning to solve global biotechnology and plant science challenges

**Syngenta, one of the world's leading agriculture and plant science companies, is collaborating with researchers in the school's Computer Vision Lab on five exploratory biotechnology-related image analysis projects. The three-year projects involve developing, adapting and applying deep learning techniques to a range of plant phenotyping derived datasets, and will run until 2021.**

Image analysis experts from Syngenta have provided the funding and image sets for a post-doctoral researcher in the School of Computer Science - Dr Aaron Jackson - to develop novel deep learned solutions for key areas for the company.

Aaron, who also completed his PhD within the school, will be specifically exploring how deep machine learning techniques can be applied to solve food production and agricultural challenges. The supplied image sets will be used to develop and evaluate new Convolutional Neural Net-based deep learning architectures and approaches. Dr Michael Pound and Dr Andy French are also providing input and guidance into the projects based on their expertise in this field.

This project, motivated by concerns over global food security, has the potential to have real-world impact by improving products and processes in the agricultural and food industries. Food production must double by the year 2050 if it is to meet the needs of a rapidly growing population, and this must be achieved against a challenging background of climate change and resource depletion. Newer, more productive varieties of food crops, and products to protect them, are needed that are robust to an increasingly harsh and changing environment. Though plant breeding methods and the tools required to study the genetic structure of plants are well-developed, techniques for characterising and assessing the structure and function of real plants are still in their infancy.

The Computer Vision Lab has also been working with Syngenta employees to capture and upload plant images via a specifically developed smartphone app, which are sent to a server at the University for analysis, and then returned to Syngenta after analysis on the Computer Vision Lab's GPU server cluster. Around 30,000 images have already been received and analysed via this new tool.



# Scanning the Horizon: Addressing challenges and trust in the digital economy

Established in 2009 and centred at the University of Nottingham, the UKRI-funded multidisciplinary Horizon Digital Economy Research Institute is part of the School of Computer Science, and represents an initial £40 million investment by UKRI, the University of Nottingham and over 200 academic and industrial partners.

Horizon consists of both a research hub and an EPSRC Centre for Doctoral Training (CDT) within the UKRI Digital Economy programme. Both the hub and CDT received follow-on funding in 2015 in recognition of the continuing impact that Horizon is delivering. The Horizon CDT in Creating Our Lives in Data received a third iteration of funding in 2019 to continue doctoral research until March 2028. In 2020 the hub was also successful in being renewed by the EPSRC for a third time.



Horizon is led by Professor Derek McAuley, and carries out a varied portfolio of pioneering digital economy research in the wild, and embeds its research in the practices of external partners spread across a wide range of industry sectors, as well as engaging with parliament and regulators to inform policy. It works with a wide range of stakeholders in order to introduce novel technologies and practices to address the challenges of ethics, privacy, security, trustworthiness and fairness in the use of smart technologies. Derek McAuley was a member of the Digital Competition Expert Panel for UK Government.

The training of interdisciplinary researchers with the expertise to work with industry and society has also been a key mission for Horizon. This has been achieved by enabling cross-disciplinary communication and understanding, which has helped develop the highly skilled future research leaders that are required to address continuing challenges in the digital economy.

Horizon is an integral part of the University of Nottingham Smarts Products Research Beacon.

For further information about Horizon, visit [horizon.ac.uk](http://horizon.ac.uk)

## Horizon at a glance:

- Horizon has received three rounds of Hub funding from EPSRC exceeding £20 million
- The initial investment of Horizon from stakeholders and partners collectively is £40 million
- It has established over 130 collaborations and partnerships across diverse industry sectors
- Horizon has delivered in excess of 1000 public engagement activities
- The hub and CDT have been instrumental in developing highly-skilled future research leaders



# Human computer interaction: Creating interactive technologies to enhance everyday life



The school has internationally recognised expertise in human-computer interaction (HCI), the multidisciplinary field of study focusing on the design of interactions between humans (the users) and computers.

Research in this area combines both an interdisciplinary approach (linking to the social sciences and humanities) with an intra-disciplinary approach (in areas such as distributed systems, AI and machine learning, vision and formal methods) to enable an end-to-end methodology in which novel digital technologies are developed and understood 'in the wild'.

Research within the school's Mixed Reality Lab (MRL) is very much grounded within the HCI field, and focuses on the creation of innovative interactive technologies to enhance everyday life in all aspects of society.

MRL research activity has had direct impact on society through the following mechanisms:

- Public engagement – via staging a series of high profile public events that have directly engaged thousands of participants, whilst indirectly reaching millions more through associated national and international media coverage
- The development of new interfaces for entertainment
- Research collaborations with art collectives and creative industries
- Users and industrial beneficiaries of global human-computer interaction research who use it to advance their products

Research collaborations have taken place with a variety of industrial partners, including BBC, Brain+, Broadway Media Centre, Google, Microsoft Research, Unilever, BAE, GE Aviation, Nokia, BT, Sony, and Scottish Power.

A number of novel provocative prototypical artefacts, interactive exhibits, and engaging artistic experiences have been produced by researchers. In doing this, the school has worked with a range of exceptional local, national, and international artists throughout the last twenty years.

An example is the European Commission-funded VRtefacts project, a museum-focused virtual reality experience designed to heighten a visitor's sense of connection and engagement with items from the collection, ending with visitors donating a personal story around that object. It is a flexible concept and can be reworked in various ways to suit different needs.

The MRL is running a series of sprint projects with Unilever's Home Care, Beauty and Personal Care Research and Development Centre involving branding and hybrid gifting.

Transferring knowledge from the MRL to industry through collaborative projects and commercialisation activities and to the general public through touring performances and installations in science centres, museums and galleries, continues to be a key school objective.





# Airport algorithm improves flight departure efficiencies at Heathrow

**Academic researchers within the Computational Optimisation and Learning Lab in the School of Computer Science have produced an algorithm that has helped solve real world flight sequencing challenges at London Heathrow, one of the world's busiest international airports.**

Over 80 million passengers travel through the airport annually on services offered by 90 airlines travelling to more than 200 destinations in over 90 countries. It has approximately 1,300 combined take offs and landings each day.

Dr Jason Atkin and Dr Geert De Maere have developed an algorithm that has helped flight schedulers improve efficiencies on scheduling flight departures by predicting the most likely order of take offs and providing an output as to when aircraft should push back from the departure gates. It does this by simulating the entire outward bound operation of the airport, by carrying out millions of calculations per second.

The algorithm informs on an efficient and safe order for the aircraft to depart via the airport's internal computer system. The output is given to air traffic controllers via the computer system and is then displayed to pilots in the form of a Targeted Start-Up Approval Time, which is the recommended aircraft push-back time.

For the airport to function both safely and efficiently, groups of similar sized aircraft need to be sequenced together for take-off, and the direction of flight departures also needs to be taken into account.

Jason explains: "The biggest benefit of the algorithm is that you can hold aircraft on stand for longer, without delaying take-off so there is no loss for passengers in terms of delays. This also means you can also start aircraft engines later, which leads to significant fuel savings per year".

**"We are very proud of the algorithm we have developed as it has helped solve a real-world large scale aviation challenge and is of beneficial use"**

Jason Atkin, School of Computer Science

Work is still continuing to further enhance the algorithm system. The Lab has also worked with Dutch airline KLM on robust airline scheduling projects, which have received technical innovation awards from the aerospace industry.

This work featured in the BBC Four TV documentary 'The Secret Rules of Modern Living: Algorithms'.

**The algorithm has led to a 46% improvement in efficient take off times**



# Collaboration in the spotlight: BBC Research and Development

The school is proud of its long standing collaborative research partnership with the BBC, the world's leading public service broadcaster. For over a decade, we have secured millions of pounds of research funding to work collectively on research projects, that focus on the internet of things and artificial intelligence. Projects have covered various societal challenges such as building privacy, trust and security into the evolving digital ecosystem.

The school has led substantial industry research projects, which have been funded by the Engineering and Physical Sciences Research Council (EPSRC), including Living with Digital Ubiquity, Databox: Privacy-Aware Infrastructure for Managing Personal Data and Experiencing the Future Mundane.

Professor Steve Benford of the school's Mixed Reality Lab was awarded one of only eight prestigious EPSRC Dream Fellowships to be a Visiting Professor at the BBC, and more recently, Professor Andrew Crabtree was awarded an EPSRC Fellowship of over £1.1 million entitled Privacy by Design: Building Accountability into the Internet of Things, which involved working in collaboration with the BBC, BT, Digital Catapult, E.ON and O2.

The BBC has supported Industrial CASE PhD Studentships within the school and has also been a key industry partner for interdisciplinary research carried out within the EPSRC Horizon Centre for Doctoral Training (CDT). It has hosted PhD student internships at MediaCityUK in Salford, as well as its previous headquarters in London.

BBC Research Scientists have also collaborated with PhD students on international public engagement events and immersive experiences such as the Mozilla Festival and The Living Room of the Future. They have co-authored academic papers that have been accepted to top international research conferences.

Horizon CDT graduate Dr Neelima Sailaja, collaborated with BBC Research and Development (R&D) for her PhD research project. She was the first student of her CDT cohort to successfully defend her thesis entitled 'Understanding the challenges of using personal data in novel media experiences'. Her research particularly focused on the ethics, trust, design, and privacy of user personal data in this area.

Neelima is now a Research Associate within the Horizon Digital Economy Research Institute at the University of Nottingham, and continues to work in collaboration with the BBC.

"The BBC R&D Team has worked with Neelima on personal data and trust, which is a significant theme for the BBC. Neelima has co-authored research papers with members of our team, participated in international workshops and also featured in a BBC demo video for object-based media"

Phil Stenton, Research Scientist, BBC R&D

## Key points:

- The school's research collaborations with the BBC have spanned more than a decade
- The BBC has sponsored doctoral research in the school via the EPSRC Horizon Centre for Doctoral Training and through Industrial CASE Studentships
- The school has leveraged more than £25 million of research funding for projects involving the BBC as partners

# Beacons of Excellence: Solving today's global challenges

The school is involved in the Beacons of Excellence that champion the University's field-leading responses to global challenges. Within this section we focus on two of the beacons – the Smart Products Beacon and the Future Food Beacon.

You can find out more about the beacons at: [nottingham.ac.uk/research/beacons-of-excellence](http://nottingham.ac.uk/research/beacons-of-excellence)

## Smart Products Beacon

Many of our academics are experts within the Smart Products Beacon, which focuses on how the digital revolution can be harnessed to make smarter and trusted products for the good of society.

This beacon is establishing a new critical-mass research activity to explore the future of products and how they are made. The vision is to transform the nature of products and their production throughout our economy. The approach combines digital and physical technologies to make products more intelligent, adaptive and experiential. These smart products will be co-created by manufacturers and consumers, drawing on advanced manufacturing and the analysis of data captured during use as part of data-driven product life-cycles. The beacon will also seek to treat people's data responsibly so that our products are trusted.

The research is inherently interdisciplinary, combining perspectives from Computer Science, Engineering, Business, Law and the Humanities. It is also grounded in real-world applications and experiences which inform and demonstrate research into fundamental techniques. We also work closely with industry partners to explore our vision across diverse sectors of the economy, from high value goods, to consumer goods and food, to digital media.



## Future Food Beacon

Dr Michael Pound is a computer scientist whose research focuses on the development of innovative computer vision techniques. Within the Future Food Beacon, Michael is working with bioscientists to apply these computer vision techniques to plant phenotyping, providing accurate measurement of the structural and functional properties of plants. The bioscientists can use this information to explain the underlying mechanisms for how plants grow.

The novel algorithms Michael has developed have been embedded into software tools that allow biologists to measure both plant shoots and root systems. These have been adopted by researchers all over the world. Data from his imaging analysis approaches is being used to inform plant breeding and genomic research. This research will have a huge impact on the ongoing problem of global food security.





# Spinning out and starting up

Being involved in partnerships, technology ventures and collaborative research projects with industry has resulted in several spin-out and start-up companies, and the development of novel innovative solutions, products and apps. Examples of these are provided below:

## BlueSkeye AI

Founded in April 2019 by Michel Valstar and Anthony Brown as a spin-out company, BlueSkeye AI was created out of the desire of its founders for their research to be able to help people through ethical AI analysis of medically relevant behaviour and to have a real impact on the world.

BlueSkeye AI's mission is to improve wellbeing and patient outcomes by building objective, accessible, scalable, affordable mobile device apps for mental health monitoring and putting them in the hands of the public as well as medical professionals.

The company will create new opportunities in the health and wellbeing sector and streamline healthcare provision through accurate, objective diagnosis, improved treatment recommendations and longitudinal monitoring of patients across the globe. For further information visit [blueskeye.com](http://blueskeye.com)

## EventMAP

This resource provides tailored consultancy and software packages that enable large organisations to optimise every facet of their resource planning and management, timetabling, scheduling and workplace change activities. Academics within the school have been working with EventMAP, which received a KTP Best of the Best Award for Best Future Innovator for this collaborative work in the emerging area of fairness measures in timetabling and scheduling.

## Staff Roster Solutions

Staff Roster Solutions Limited develop, licence and support world leading workforce scheduling engines. The algorithms and solvers at the core of the engines have been researched and developed over a number of years, including many years of PhD led research at the University of Nottingham. We continue to maintain close links with the academic research community in order to benefit from new advances in scheduling and optimisation theory. For more information see [staffrostersolutions.com](http://staffrostersolutions.com)

## Webroster.net

Computer Scientists Dario Landa-Silva and Rong Qu completed a successful KTP project in collaboration with Webroster Ltd and the project was rated as outstanding by the Innovate UK panel of assessors, and a certificate of excellence was issued in recognition of this achievement. The aim of the KTP was to improve homecare workforce utilisation by developing an adaptable software optimisation engine to solve workforce scheduling and routing problems. Outputs from the KTP were beyond expectations, resulting in Webroster being in a position to launch the optimisation product and the academic team producing several research papers as a result of the work, that were published in leading academic journals and presented at international conferences.

## Entrepreneurial PhD students

PhD graduates from the school have also successfully launched or been involved in start-up companies. In 2017, Sam Howard co-founded Userfy, a Nottingham-based user experience research agency. Horizon CDT graduates Matthew Terrell, Daniel Ratzinger and Martin Krusimagi developed the [callforparticipants.com](http://callforparticipants.com) platform which went on to be acquired as a Jisc Beta service. Call for Participants is now a self-sustaining service to ensure value for money for the academic sector. Will Preston and Timur Almaev are both now working at spin-out company BlueSkeye AI.

# Celebrating women in science



The school strongly encourages and recognises commitment to advancing the careers of women in science, technology, engineering, maths and medicine (STEMM) employment in higher education and research.

## Ada Lovelace Day

Countess Ada Lovelace (1815 - 1852) was a gifted British mathematician. She is regarded as the first computer programmer in history, as she was the first person to recognise that the Analytical Engine, designed by Charles Babbage, had applications beyond pure calculations. She published the first algorithm intended to be carried out by such a machine, which is now considered the first computer program.

The Ada Lovelace Day is an international celebration of the achievements of women in STEMM. It aims to increase the profile of women in these disciplines and create new role models to encourage girls into STEMM careers.

Dr Carolina Fuentes and Dr Mercedes Torres Torres are the driving force behind Ada Lovelace Day at the University of Nottingham. They organise the annual Ada Lovelace Day celebration which attracts inspirational expert female speakers from both industry and academia.

## Athena SWAN Charter

The school holds an Athena SWAN Bronze Award, and is coalescent with wider University initiatives such as WinSET (Women in Science and Technology) and our links to UK and EU initiatives aiming to promote science to women, support and inspire them to make decisions that are right for them: #NotJustForBoys and Science: It's a Girl Thing!

## Code First: Girls

In 2019, the school collaborated with Code First: Girls, winners of the 2019 #TechWomen100 Company of the Year Award, to deliver an introductory coding course for university students. During the eight-week programme, participants developed the skills to build their first website. Feedback from attendees was extremely positive. The event was organised by Dr Mercedes Torres Torres and Dr Carolina Fuentes, with school staff and students with relevant expertise volunteering to deliver the training to participants.

## #techmums

Staff and PhD students within the school were instrumental in bringing the national #techmums initiative to Nottingham in 2016 after collaborating with founder Professor Sue Black OBE on previous events. The charity #techmums was established in 2012 and offers a range of training to women ranging from online safety to basic coding, allowing them to embark on a new career path and gain confidence regarding returning to employment, continuing education or starting their own businesses. The Nottingham five-week pilot course was delivered for a group of mums at the city's Top Valley Academy, with their graduation ceremony being held within the school at the University of Nottingham.

## TechUP Women

TechUP Women retrains women from the Midlands and North of England, many from underrepresented communities, into tech careers. The school is involved in this initiative, funded by the Institute of Coding, in collaboration with colleagues from Durham University, Edge Hill University and the University of York.

Focusing particularly on women from BAME and underrepresented communities, TechUP provides an intensive six-month course to transform or kick start careers in the technology sector. The programme is open to applicants with degrees in any subject area and a passion for technology.

The programme began with a residential weekend hosted at Durham University in July 2019 and ended with a residential weekend and graduation hosted by the University of Nottingham in January 2020. The main content of the course is online, with all participants coming together for weekends over the six month duration.

Support is provided throughout the programme through an online portal, regular online catch up sessions and weekly online meetings with an industry mentor. Industry partners involved include Atom Bank, Capital One, Experian, tombola and Mastek. For more information visit [techupwomen.org](http://techupwomen.org)



# Staff in the spotlight

## Professor Boriana Koleva, Mixed Reality Lab

**Expertise:** Human-computer interaction, new data-driven products, digital hybrid gifting

Boriana is Professor of Computer Science, based in the Mixed Reality Lab. In August 2020 she will become Director of the Horizon Digital Economy Research Institute. Her research area is the field of human-computer interaction, particularly designing, deploying and studying 'in the wild' new hybrid products, which flexibly combine physical artefacts with digital media to deliver powerful consumer experiences.

## Associate Professor Rong Qu, Computational Optimisation and Learning Lab

**Expertise:** Transport logistics scheduling, vehicle routing, cybersecurity for connected and autonomous vehicles, evolutionary algorithms

Rong is a member of the Computational Optimisation and Learning Lab, and her research focuses on developing intelligent solutions for real-world problems including transport logistics scheduling, vehicle routing, cyber security for connected and autonomous vehicles (CAVs), personnel scheduling, portfolio optimisation, multicast network routing and timetabling. She has been lead or co-investigator for various internationally funded large-scale projects, including award-winning knowledge transfer projects with industry. Rong's most recent grant was awarded from Innovate UK to co-lead a multidisciplinary research project around AI-driven secured CAVs.

## Professor Michel Valstar, Computer Vision Lab

**Expertise:** Affective computing, automatic human behaviour understanding, machine learning

Michel is an expert in the fields of computer vision and pattern recognition, where his main interest and world-leading work is in automatic recognition of human behaviour, specialising in the analysis of facial expressions. Within the University of Nottingham Smart Products Beacon he leads the work on interactive AI systems, endowing robots and AI agents to sense humans and their behaviour in order to plan their own actions appropriately. In April 2019 Michel co-founded spin-out company BlueSkeye AI with Dr Anthony Brown, who is also a Business Science Fellow at the University. The TrueBlue mental health condition diagnosis app was one of their first revolutionary products.

## Professor Christian Wagner, Lab for Uncertainty in Data and Decision Making

**Expertise:** Cybersecurity, uncertain data, data analysis, data-driven policy design, AI techniques

Christian is Director of the Lab for Uncertainty in Data and Decision Making and his research investigates the modelling and handling of uncertain data arising from multiple sources for decision support and data-driven policy design. His recent work focuses on developing methodologies around the quantitative capture of uncertain data from humans via novel data analysis techniques. Christian has attracted over £10 million of research funding for the school as principal or co-investigator. His work spans theoretical contributions in Computer Science as well as a strong focus on interdisciplinary collaborations. He has co-developed multiple open-source software frameworks, making research outputs accessible to peer researchers.

## Professor Thorsten Altenkirch, Functional Programming Laboratory

**Expertise:** Type theory, constructive logic, conceptual programming

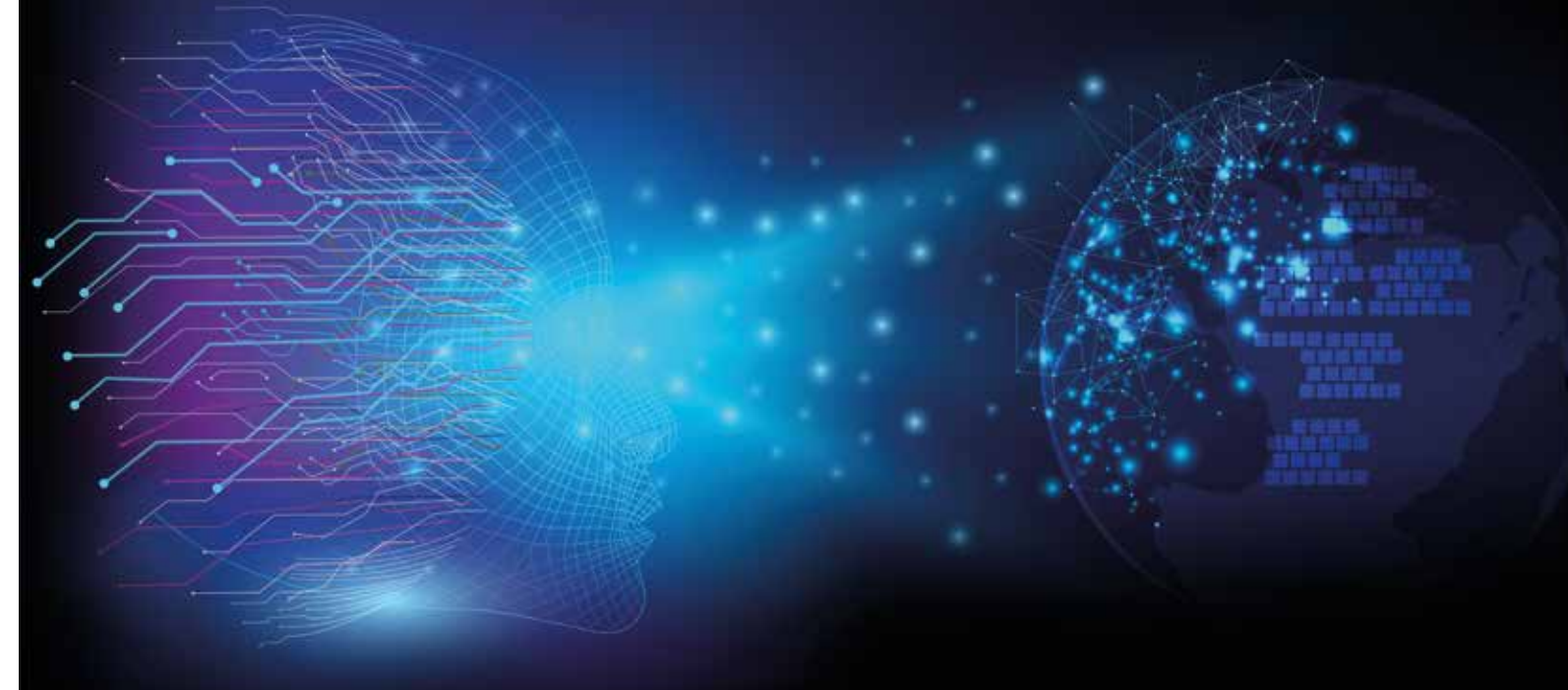
Thorsten previously worked as a computer programmer in Germany for various companies. He became immersed with more theoretical realms whilst completing a PhD on Type Theory in Edinburgh. Following employment in Gothenburg and Munich, he started the millennium by joining the School of Computer Science, where he co-founded the Functional Programming Laboratory with Professor Graham Hutton. Thorsten held his inaugural professorship lecture 'The Tao of Types' in autumn 2019. During the same year he published the book 'Conceptual Programming with Python' with co-author Dr Isaac Triguero. Thorsten has produced various videos for the Computerphile YouTube channel, with the most recent achieving over half a million views.

## Graziela Figueredo, Research and Innovation Lead, Digital Research Service

**Expertise:** Data science and analytics, intelligent data solutions, systems simulation

Graziela is Research and Innovation Lead for the Advanced Data Analysis Centre within the Digital Research Service, and her expertise is in system simulation technique development and intelligent data analysis. She has worked on multiple KTP projects with organisations such as Unilever, Microlise, Ford, and Gleeds. Graziela is currently leading in a multidisciplinary KTP project with the School of Architecture and Gleeds Cost Management. This is driving innovation by enabling Gleeds to benefit from an AI-based methodology to automate their risk-based construction cost models and inform robust strategic business decisions. It will also help improve efficiencies and attract new skilled people into industry.

# What's next?



## Research strategy: Planned programme of expansion

Our next strategic research development and expansion phase includes the following priorities and areas:

- Moving towards becoming a centre of research excellence for artificial intelligence
- Expansion of research activity in the cyber-physical research area and associated research facilities
- Development of robotics labs, facilities and research expertise
- Continued involvement in the University of Nottingham Research Beacons of Excellence and other multidisciplinary strategic priorities
- Doctoral training - expansion of cohort-based multidisciplinary doctoral training, specifically in the area of artificial intelligence. Continuing the success of EPSRC Horizon Centre for Doctoral Training in Creating our Lives in Data, which received its third award of UKRI funding to continue PhD studentships in collaboration with industry until 2028

## Future opportunities for industry collaborations

The school is also interested in partnering with industry via the following activities:

- Hosting external speakers and experts from industry
- Organising industry sandpit challenges, sprint projects, programming competitions and hackathons
- Event sponsorship and keynote addresses (for example Ada Lovelace Day, the annual HackNotts competition)
- Provision of year-out placements and projects for undergraduate and postgraduate taught students
- Software, applications, spin-out products and algorithm development
- Sponsorship of early career researchers on specific projects to help solve industry challenges
- Contributing to the University's response to the coronavirus crisis, including its commitment to supporting communities, partners and the global effort