THE UNIVERSITY OF QUEENSLAND
AUSTRALIA

Artificial Intelligence, Machine Learning and Data Science — UQ capabilities

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The University Of Queensland
AUSTRALIA

Artificial Intelligence, Machine Learning and Data Science

Contents

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The University of Queensland recognises the long-term implications of AI and is committed to driving innovations in AI research and its application.

Introduction

Advances in computer power and big-data analysis or digitalisation have underpinned the pathway to Artificial Intelligence (AI), which can be described as the capacity or ability of a machine to learn and solve problems mimicking the human mind.

Digital transformation is dramatically changing the way business operates, engaging almost every sector of the economy along the way.

Artificial Intelligence is also a powerful tool to improve business processes and will have a global impact on the future workforce through the transformation of the relationship between people and technology.

Advancements in AI are expected to contribute as much as US$15.7 trillion to the global economy by 2030 and AU$315 billion to the Australian economy by 2028.

The University of Queensland recognises the long-term implications of AI and has invested strongly in building capability in AI research and its application.

Artificial Intelligence at UQ

AI capability at UQ cuts across both fundamental and applied research, as well as a broad range of outreach and educational activities.

AI research and its applications can be broadly categorised into research strengths, impact areas and services.

The research strengths of UQ in AI, include machine learning (ML) and data science (DS) and present a strong portfolio of fundamental knowledge critical for the future of AI.

At the same time, there is a significant capability at UQ on key impact areas that target solutions for complex global problems across multiple industry sectors.

Detecting fake news through AI

The ability to algorithmically spread false information through online social networks together with the data-driven ability to profile and micro-target individual users has made it possible to create customised false content.

Fortunately, similar data-driven and AI methods can also be used to detect misinformation and to control its spread. Dr Gianluca Demartini has partnered with Facebook to:

- develop automatic fake news detection systems
- investigate the possibility of generating information credibility literacy tasks that can give people the skills to recognise fake news.

Low energy mobile devices

Browsing the internet involves transferring user behavioural data to a large-cloud based system, which in turn are massive consumers of energy.

Dr Hongzhi Yin has developed a cost-effective, low-energy mobile system to process the information.

This eliminates the need for transferring information to cloud systems (reducing CO_2 emissions), and protects a user's private information.

Data Management and Data Science

Big-data analysis

Big-data analysis relates to conducting multi disciplinary research on large-scale, unstructured, multi-modal and complex data to find innovative and practical solutions, and to create value from big data in business, scientific and social applications.

Dr Hongzhi Yin is the current director of the Responsible and Sustainable Big Data Intelligence (RSBDI) Lab. The RSBDI lab strives to develop energy-efficient, privacy-preserving, robust, explainable and fair data mining and machine learning techniques with theoretical backbones to better discover actionable patterns and intelligence from large-scale, heterogeneous, networked, dynamic and sparse data. RSBDI lab joins forces with urban transportation, healthcare, agriculture, e-commerce and marketing fields to help solve the societal, environmental and economic challenges humanity faces.

Large-scale spatiotemporal data

Prof. Xiaofang Zhou leads research on large-scale spatiotemporal data processing. He focuses on developing advance knowledge and techniques from data quality management, data storage and high-performing processing to data mining and ML for trends prediction in spatial information systems, intelligent transport systems, IoT, and streaming sensory data.

Information resilience

Multiple industry reports and recent media coverage identified 'data gone wrong' as the biggest risk factor for AI and other emerging technologies, and its impact is increasingly recognised as a threat from mundane cyber-criminals to sophisticated well-funded entities, raising concerns of national security. Information resilience is the capacity of organisations to build, protect, and sustain agile data pipelines, capable of detecting and responding to failures and risks across the value chain in which the data is sourced, shared, transformed, analysed, and consumed. The success of AI's implementation will require robust mechanisms and capacity building around information resilience. Prof. Shazia Sadiq leads research to address these issues, including:

- Responsible use of data assets (principled approaches to data governance, access and sharing)
- Data curation at scale (machine learning, crowd-sourcing and human-in-the-loop techniques)
- Algorithmic transparency (approaches to promote interpretability, uncertainty quantification unbiasedness, transparency and reproducibility in the design of learning algorithms)
- Trusted data partnerships (data literacy, trust in data linking, lifting barriers to data sharing)
- Creating value from data (data monetisation, business process improvement, measuring analytics value and organisational structures).

Information retrieval

Prof. Guido Zuccon investigates how people are using search engines to seek health advice on the web. Widely disseminated by the media, the work shows that less than two-thirds of those who search online to make health decisions then go on to consult a health professional with regard to their health conditions.

Computer vision and multimedia computation

Computer vision

Computer vision concerns itself with the understanding of the real world through the analysis of images. More specifically, it infers properties of the observed world from an image or a collection of images. Computer vision has attracted considerable attention from industry and academia for its wide range of applications, many of which have economic value.

Prof. Anders Eriksson and his team lead research on:

- 3D reconstruction
- Deep Learning
- Image segmentation
- Geometry processing
- Medical image analysis
- Skin cancer diagnosis

Object recognition

Object recognition is the ability to recognise what objects an image shows. The technology behind it aims to extract robust features from objects to improve detection and recognition, and provide solutions for real-time applications such as surveillance.

Being able to detect and recognise human faces and their emotions from facial expressions is an important part of the recognition process.

Big Media Data Analytics

The Big Media Data Analysis group conducts large-scale multi disciplinary research on unstructured, multi-modal and complex data, achieving human-understandable machine intelligence for multimedia, social media, health data analytics and knowledge discovery.

The group is developing AI-powered technologies to enable tangible benefits for the whole-of-society, ranging from applications such as autonomous vehicles, image/video content understanding and retrieval, event detection to user behaviour analysis, and recommender systems. The Big Media Data Analysis Group has been engaged in several cross-disciplinary projects with social science, chemical engineering, and advanced water management teams to extend the boundaries of their research and generate impact to other scientific disciplines.

Explainability in Machine Learning

A/Prof. Helen Huang and Prof. Xiaofang Zhou lead the Data Science Group. Using state-of-the-art and deep learning techniques, they are developing interpretable deep models in many data-rich fields.

In health-related projects, they seek to achieve high performance in medical prediction tasks such as illness severity prediction in ICUs, but addressing explainability issues raised by black-box models.

Machine learning and data mining

Explainability in ML

Dr Sen Wang's research focuses on developing interpretable deep models in many data-rich fields to provide insights into the data, variables and decision points used to make a recommendation. In health-related projects, Dr Wang's research has significant applications in health informatics and social media.

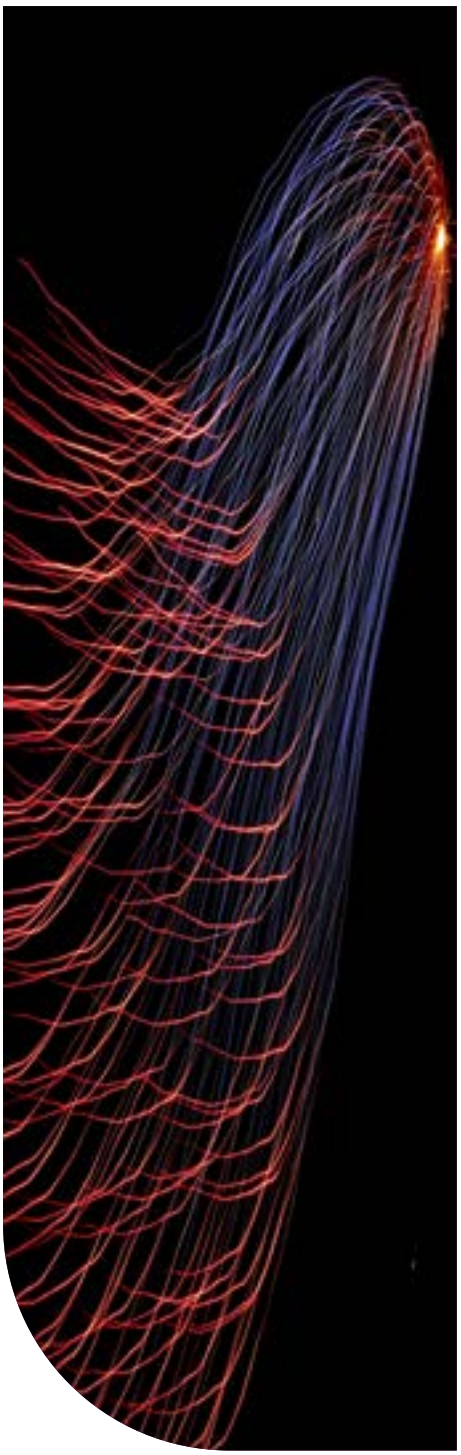
Theoretical aspects of semi-supervised learning

Prof. Geoffrey McLachlan is a UQ expert in semi-supervised learning (SSL), an AI method that analyses datasets comprised of both labelled and unlabelled training observations. SSL aims to classify the unlabelled data using the existing information of the labelled data.

ML and data mining

Dr Mahsa Baktashmotlagh's research focuses on developing machine learning and data mining techniques and applying them to diverse contexts including:

- Visual data analysis (visual domain adaptation, video classification, and animal's foraging behavioural analysis)
- Road traffic networks (mining large scale road traffic networks and building a road-load balancing tool to predict congestion on any road in the city)
- Biomedical data (prediction of neonatal sepsis)
- Finance (hedging foreign exchange trading risks).



Optimisation and statistics

Novel optimisation algorithms

Dr Fred Roosta-Khorasani and his research team design, analyse and implement novel optimisation algorithms for training modern machine learning problems.

The underlying approaches draw from randomised techniques, statistics, non-convex non-linear analysis, geometry, and parallel/distributed computing. Dr Roosta-Khorasani is also interested in using novel ML models for scientific discovery, in particular the design of innovative physics-aware deep learning models and the development of their statistical learning theory.

Sequential decision making under uncertainty

Sequential decision making under uncertainty is a recurrent challenge in several related fields, including AI, control theory and statistics.

To better understand randomness, Dr Nan Ye and Prof. Dirk Kroese use Monte Carlo simulations.

Their research aims to develop theoretical and algorithmic tools to address the challenge of scaling-up existing methods to large complex environments, and explore their application in sustainable fishery management.

To approach these challenges, they use partially observable Markov decision processes (POMDPs) and Monte Carlo techniques.

POMDPs provide a general mathematical framework for sequential decision making under uncertainty. Both theoretical and algorithmic approaches will be applied to sustainable fishery management — an important problem for Australia and an ideal context for POMDPs.

The project will advance research in artificial intelligence, dynamical systems, and fishery operations, and benefit the national economy.

Evolutionary algorithms and optimisation

Dr Marcus Gallagher's research interests include AI and nature-inspired problem solving techniques and algorithms. More specifically, his work focusses on optimisation, metaheuristics and evolutionary computation, machine learning and exploratory data analysis and visualisation. He uses statistical and probabilistic models and techniques to address these challenges.

Statistics and probability

Dr Yoni Nazarathy's research expertise lies in applied mathematics and statistics with a focus on stochastic operations research, scheduling, resource allocation, optimisation, data science and computer-controlled systems.

Language technologies

Language technologies studies how computer programs can analyse, produce, and respond to human texts and speech, and develop tools to enable computers to recognise human language.

Prof. Janet Wiles leads research in technologies involving language recognition, processing, production and evaluation.

The Centre of Excellence for the Dynamics of Language (CoEDL) is an umbrella group for language projects.

The centre is involved with several language technologies such as Elpis speech-to-text, Opie social robots, and Florence (supporting communication for people living with dementia).

Human centred AI and design

Extended reality (XR)

XR is a technology that covers both Mixed Reality (AR) and Virtual Reality (VR), Dr Arindam Dey's research aims to design novel interfaces using both AR and VR, individually and combined (XR) in multiple application domains including but not limited to remote collaborations, effective computing, gaming, education, health, and sustainability in collaborative applications.

Visual SenseMaking

Dr Mashhuda Glencross's research group aims to create visual mechanisms to understand large data sets from multiple sources, develop meaningful visuals, narratives and build literacy about the data. Her research team focuses on visualisation, energy data, sense making, human-in-the-loop, virtual reality, simulation, visual analysis, and storytelling. They use AI methods to narrow the scope of what data to visualise and to aid automatic creation of techniques and metaphors to experience the data.

Emotions and e-wearables

The detection of emotions using smartphones/wearable sensors and personal informatics is becoming increasable popular. Dr Chelsea Dobbins's research focuses on the area of lifelogging, i.e. how our lives can be logged through the use of wearable sensors and mobile devices.

In this context, she uses AI methods to:

- Visualise unconscious emotional processes and increase self-awareness to promote positive coping strategies to protect future health.
- Detect emotions using physiological and neurological signals to make virtual and augmented reality interfaces adaptive and communicative of such emotional states.

Bias and Fairness

AI sometimes makes systematic errors that may lead to bias and unfair decisions. At UQ, we investigate human-centred AI methods to better understand the causes of and to better deal with bias and fairness in AI. Examples of our research include: studies on online misinformation aimed at understanding how it spreads and how it is perceived by people, AI models to understand and predict online user interaction behaviour, and methods to reduce AI mistakes that are difficult to be automatically detected.

Impact areas

Digital pathology

UQ's high-performance computer, Weiner, is now able to deliver unprecedented performance for image processing and deep learning algorithms, allowing advancements in digital pathology.

The team behind this initiative includes UQ's Professor Lovell and Dr Arnold Wiliem, as well as Peter Hobson and Anthony Jennings from Sullivan Nicolaides Pathology.

Healthcare and medicine continues to be an outstanding impact area for UQ with significant background IP and world-class research leadership.

Digital pathology

Prof. Brian Lovell leads UQ's Digital Pathology team. The team aims to develop technologies that make pathology workflows faster and more efficient.

Prof. Lovell has collaborated with Sullivan Nicolaides to continuously create computer image datasets from different pathology areas to further advance the field.

Medical imaging

Prof. Stuart Crozier's expertise lies in imaging technology and applications instrumentation for physiological measurement and semi-automated diagnostics.

The commercial and academic impact of his work in Magnetic Resonance Imaging (MRI) has been significant.

About two-thirds of all high-end, clinical MRI systems installed worldwide after 1997 contain patented technology co-invented and developed by Prof. Crozier.

Movement neuroscience and computational neuromechanics

Prof. Paul Hodges' research team aims to understanding neuromechanical mechanisms that underlie healthy and impaired sensorimotor function. Our approach involves the use of machine learning and AI techniques to generate computational models of human function and behaviour.

Neuroengineering and rehabilitation

Dr Alejandro Melendez-Calderon's research team aims to understand and aid the recovery of, assistance or replacement of, functions lost because of neurological diseases or injuiries such as stroke, traumatic brain injury, Parkinson's disease, or spinal cord injury. This is an interdisciplinary field of research at the interface of neuroscience, engineering and AI, and deals with the understanding of neurological principles and design of technology that is meant to improve the quality of life of people with disabilities.

Brain development and information processing

Prof. Geoffrey Goodhill is interested in how brains process information, particularly during development.

This includes how growing nerve fibres use molecular cues to make guidance decisions, how map-like representations of visual inputs form in the optic tectum and visual cortex, and how these maps code sensory information. His research team uses a combination of mathematical, experimental and computational techniques to help test hypotheses about the biological mechanisms that drive these changes during development.

Impact areas

Brain activity and functional MRI

Prof. Markus Barth is developing very fast functional MRI techniques with the highest spatial resolution possible.

He is particularly interested in identifying the small functional units of the brain, such as cortical layers and columns, and to better understand brain function.

Laser technology and early detection of cancer

Prof. Aleksandar Rakić leads UQ's Photonics and Microwave Engineering group.

His research focuses on the development of technologies for sensing and imaging across the electromagnetic spectrum including microwave, terahertz wave and optical systems. His research team is developing disrupting technologies based on the terahertz quantum cascade lasers (QCLs) for the next generation of terahertz imaging systems suitable for early detection of skin cancer.

Predicting from complex data

Dr Alina Bialkowski is a computer vision, ML and signal processing algorithms researcher, working on applications in medical imaging and intelligent transport systems.

Her research interests include extracting information from complex data to model patterns and developing interpretable models to solve real-world problems.

ML for acute kidney injury in COVID-19 patients

COVID-19 has no established protocols for treatment to kidney injury. Around one third of patients hospitalised with COVID-19 have significant injury to their kidneys. We currently have very limited understanding of how, why, and when the kidneys are injured during infection with COVID-19, and no proven strategies to prevent the condition.

The International Severe Acute Respiratory and Infection Consortium (ISARIC) - Acute Kidney Injury Analysis is an observational study collecting hospital data from 64 countries around the world. In collaboration with Oxford University, the UQ data team led by Dr Sally Shrapnel aims to:

- Characterise acute kidney injury in COVID-19 patients.
- Develop a predictive algorithm to identify COVID-19 patients at high risk of kidney injury
- Validate and deploy this algorithm in a resource poor setting (Latin America).

Clinical informatics

Dr Clair Sullivan is a leading Australian researcher on electronic medical records and the digital transformation of health systems. Dr Sullivan leads the Queensland Digital Health Research Network, which is a transdisciplinary group of researchers focussed on delivering better healthcare outcomes using digital technology. She specialises in the creation and integration of decision support (including AI) into routine clinical care. She is an expert in the deployment, governance and safety of digital solutions in healthcare.

Biomedical Applications and Devices

Dr Philip Terrill leads research on novel medical diagnostic tools and therapies with the goal to improve the health outcomes of people in Australia and globally and bridge the gap between clinical physiology and biomedical engineering.

His research focusses on the application of AI, ML-based solutions and robotics to the data-driven analysis of medical conditions such as sleep apnoea and osteoarthritis, as well as the study of human sensorimotor control, neuro-rehabilitation and human augmentation technologies.

Automatic medical image analysis

Dr Shakes Chandra leads research on automatic medical image analysis. His expertise includes image processing, ML, discrete tomography and medical image analysis.
More specifically, he has developed deformable models and ML algorithms for knee, hip and shoulder-joint segmentation for deployment on the Siemens Syngo platform.
UQ is applying the automatic medical image analysis tool to:

- Complete 3D reconstruction of individual bodies with every mole marked, analysed, and compared with previous scans to assess and diagnose any potential skin cancer
- Develop AI and ML-based algorithms to automate the analyses of clinical imaging and to model the biomechanics of joint function, while translating such technologies for industry partners such as Siemens Healthcare, Germany.

Bioinformatics

Bioinformatics draws on computer science, math and statistics to enable discoveries in molecular biology data. Of particular interest is the application of AI and machine learning (ML) that promises to leverage the information hidden in massive datasets that are currently being generated by genome sequencing based technologies.

A/Prof. Mikael Boden and his group's aims to investigate, develop and apply the theory and practice of AI, statistical ML, data mining and probabilistic methods to understand and resolve a range of open problems in genomics, molecular and systems biology.

There is a need to use scientific expertise to distinguish patterns in extremely high-dimensional feature spaces that are biologically meaningful from those that are artefacts of the data generation process, ML, discrete tomography and medical image analysis.

The Boden group is actively collaborating with scientists in genomics, epigenetics and protein science, and is regularly developing methods, embedding ML and AI algorithms, that are then used by the scientific community.

AI in skin cancer diagnostics

Australia has the highest rate of skin cancer in the world, with hundreds of thousands of new diagnosed cases each year, and early detection is one of the most important factors in their prognosis. Today the most effective method for improving the early detection rate is patient skin self-examination complemented by physician directed examination. Prof. Anders Eriksson and his team are developing technology to automate patient skin self-examination, providing the means to conduct convenient and personal full-body scans for the purpose of ongoing AI driven monitoring of skin health. Presenting the general public with this ability would allow skin cancer to be detected at a much earlier stage and thereby dramatically increasing overall patient survival rates.

Wrist-worn devices including clinical research and consumer devices can provide a high volume of meaningful data about everyday routines.

Machine learning and data mining

AI/ML and accelerometry devices
Prof. Simon Smith leads the Sleep and Health Group, with the broad aim to bridge the biological and social sciences for community benefit.
His research team uses AI/ML to analyse accelerometry and other indicators of behavioural rhythmicity in natural settings to differentiate and understand sleep-wake and activity states.
Wrist-worn devices including clinical research and consumer devices can provide a high volume of meaningful data about everyday routines.
Prof. Smith's research team leads a study seeking to classify high-frequency activities (e.g. on-road driving) from actigraphy using contemporary AI/ML approaches.

ML and decision-making
Dr Tennakoon Mudiyanselage's research uses health and administrative data to develop explainable ML learning models to support decision-making. She has applied unsupervised ML methods to develop effective approaches to discover knowledge from social media networks based on user interaction patterns.
In one of her projects at the Institute for Social Sciences Research (ISSR), she explored the effectiveness of these methods to identify children, admitted to paediatric intensive care units in Queensland, at risk of poor future educational outcomes.

Impact areas

Machine vision and social responsibility

Social platforms currently include 'machine vision' systems that automatically classify faces, expressions, objects, and brand logos in images. Data from machine vision systems is used to provide targeted content to users, often without their knowledge and sufficient public oversight. Dr Nicholas Carah uses a novel combination of computational and cultural research methods to:

- Examine how machine vision works in platforms such as Instagram
- Explore their role in everyday visual contexts (festivals, food, and lifestyle sports)
- Improve public understanding of machine vision systems.

Protecting children

Prof. Rhema Vaithianathan and her team developed the world-first Allegheny Family Screening tool (AFST), a child maltreatment decision support tool implemented by Allegheny County, PA (United States) in 2016, with the team's approach widely praised as transparent and inclusive. The AFST is a predictive risk modelling tool that rapidly integrates and analyses hundreds of data elements for each person involved in an allegation of child maltreatment.

Critical parallel and complementary areas demonstrate UQ's capacity in end-to-end solutions and recognition of societal/business challenges in AI.

Data for action in government

Finding ways that machine learning tools can support high stakes decisions by government agencies is the focus of research by Prof. Rhema Vaithianathan and her team at the Centre for Social Data Analytics.

Prof. Vaithianathan works closely with agencies to develop and implement machine learning tools that harness existing data to support decision making in health and human services. The use cases for these tools are helping agencies to address the challenges of child maltreatment, homelessness and elder abuse.

From the early stages of these translational research projects, Prof. Vaithianathan's team focus is on the effort on the human concerns that determine community comfort (like equity, ethics and transparency of the tools) as well as, the data science itself.

Social impact of AI and future of work

Prof. Greg Marston's research interests are on the social impact of AI and automation in the future of work.

He focuses on the welfare-work nexus and the changing nature of employment, including the gig economy.

He has written various submissions and given evidence at government inquiries into the future of work.

He has undertaken research on Uber drivers, e-government and addressing inequalities associated with automation through basic income proposals. He is also interested in public policy approaches to regulating AI to reduce bias and increase transparency in algorithmic decision-making.

AI in the public discourse

Dr Stan Karanasios's research focuses on how organisations use, adapt, and navigate new digital technologies.

He is currently working with a leading European car manufacturer to examine ways of re-imagining work process to accommodate increasingly digital products.

AI and government accountability

Governments have been using digital technologies for decades, with implications for the operation and power of the state, and its relationship with the governance of citizens.

Increasingly, algorithmic government and AI is heightening concerns with government accountability and transparency, and the reproduction of bias, discrimination and inequalities.

Charting these dynamics and developing policy and governance frameworks is important.

Prof. Paul Henman's current research covers the nexus between social policy, administration and digital information technologies.

Impact areas

Trust and ethics in AI

In recent years, Australia has seen national inquiries into institutional failures and trust breaches by the banking and financial services sector, aged care, churches and sporting organisations. Long-term sustainability of business depends on trust and goodwill, ethical and trustworthy organisational conduct requires robust governance systems that benchmark and assess performance and culture. Prof Nicole Gillespie co-leads the Trust, Ethics and Governance Alliance (TEGA) initiative aiming to address complex and rapidly evolving challenges in society, such as the rise of advanced technology and artificial intelligence, and unprecedented challenges on managing trust, ethics and governance issues.

AI and its application in Education

There is a growing consensus that applications of AI in education have a transformational impact on the educational landscape. The UQ AI in Education research group led by Dr Hassan Khosravi draws on insights from the learning sciences and techniques from the fields of human-computer interaction, human-centred AI and learning analytics to design, implement, validate and deliver technological solutions that contribute to the delivery of learner-centred, data-driven learning at scale.

Use of AI by government organisations

Dr Ida Someh's research focuses on organisational and societal impact of data, analytics and artificial intelligence.

She is currently investigating how government organisations can develop and deploy successful AI applications with significant public value.

Despite its potential, AI uptake is still low. The study analyses the challenges of AI uptake, and how to mitigate them.

The process involves qualitative surveys to industry contacts that have delivered AI solutions to the public sector.

After gaining insight on the types of AI projects carried out and the most common challenges experienced, a deeper analysis into a select number of cases follows through interviews and other in-depth data-collection methods such as ML, government AI implementation, AI explainability and human-AI teaming methods.

Educational crowdsourcing to support personalisation

Educational crowdsourcing to support personalisation: Adaptive educational systems (AESs) make use of data about students, learning processes, and learning products to adapt instructions for each student. AESs rely on learner models that capture an abstract representation of a student's ability level based on their performance and interactions with the system. AES uses information from the learner model to recommend items from a large repository of learning resources that best match the current learning needs of a student.

These resources are commonly created by domain experts. RiPPLE is a UQ developed and supported AES that takes the crowdsourcing approach of partnering with students, also referred to as learner sourcing to create the resource repository. , To date, RiPPLE has been implemented in over 70 courses across a range of disciplines including Medicine, Pharmacy, Psychology, Education, Business, Computer Science and Biosciences.

Intelligent learning analytics dashboards

Learning analytics dashboards commonly visualise data about students with the aim of assisting students and educators in understanding and making informed decisions about the learning process. To assist with making sense of complex and multi-dimensional data, many learning analytics systems and dashboards have relied significantly on AI algorithms based on predictive analytics. While predictive models have been successful in many domains, there is an increasing realisation of the inadequacies of using predictive models in decision-making tasks that affect individuals without human oversight. To address this challenge, Dr Khosravi's team have developed a learning analytics dashboard called Course Insights that employs a suite of state-of-the-art algorithms, from online analytics processing, data mining and process mining domains, to present an alternative human-in-the-loop AI method to enable educators to identify, explore and use appropriate interventions for subpopulations of students with the highest deviation in performance or learning process compared to the rest of the class.

Impact areas

Implementing complex and even inscrutable Artificial Intelligence

Dr Tapani Rinta-Kahilsa's research adresses current issues on socio-technical change in organisations.

His focus areas include the organisational implementation of AI and automation, the identification and prevention of technologies' negative effects on individuals and organisations, as well as the discontinuance of incumbent information technologies.

Digital transactions

A/Prof. Adrian Athique is an expert in cultural studies in Asia. His research interests include digital media and society, transnational media in Asia, technology and economy of media systems, digital imaging and visual sociology. He currently leads a project on digital transactions in India.

Digital transformation

Prof. Andrew Burton-Jones's research group studies how organisations learn to use new information systems effectively. The success of any organisation digital journey will depend on their use of data and analytics. A major focus is ensuring their effective understanding and use of data and analytics to improve practices and institutions. He leads a large program of work with Queensland public hospitals on their digital transformation journey.

The topics studied range from individual-level studies (how data is input, retrieved/extracted, and its quality maintained), to socio-technical studies (how groups interact with data, how practices change), and through transformation topics (how organisations and sectors can improve).

Impact areas

AI and mining equipment

The development of AI and ML techniques has made possible the design of autonomous vehicles.

Self-driving cars will play an important role in the near function of transportation systems as they could be more safe, efficient and generate lower carbon emissions.

Prof. Ross McAree's research has made contributions to vehicle automation through the application of AI/ML/DS techniques to learn about traction parameters on road segments and fault detection and identification.

FastStack — evolutionary computing to stack desirable alleles in wheat

FastStack is an AI platform currently under development (2018–2022) by Prof. Ben Hayes in collaboration with LongReach Plant Breeders to assist the accelerated production of wheat varieties with superior performance traits. If successful, Australian growers will undoubtedly benefit as well.

Mining

AI and mining equipment

Prof. Ross McAree's research group has been involved in the development of several automation technologies that have been commercialised for the mining sector.

These outputs have benefited the global mining industry by more than $1BN.

Prof. McAree led the development and demonstration of the world's first fully autonomous mining excavator as part of a 10-year collaboration with Joy Global Surface Mining (now part of Komatsu).

He has also collaborated with Caterpillar Inc. to develop and trial the world's first autonomous bulldozer capable of production dozing using the 'pivot push' method.

Prediction in mining

Prof. Peter Knights' research relates to maintenance and reliability engineering. He has promoted the now-widespread use of logarithmic scatter plots (also known as jack-knife diagrams) to characterise and prioritise downtime events.

Dr Mohsen Yahyaei leads the Advanced Process Prediction and Control (APPCo) program, which aims to transform unit process modelling and simulation.

Human-system integration in mining automation

The introduction of automation to mining has great potential to reduce safety and health risks by removing people from hazardous situations.

For a system to function optimally, human abilities and limitations must be considered in the planning, design, development, and evaluation processes.

Prof. Robin Burgess-Limerick is an experienced human factor and ergonomics researcher.

His current projects are in the areas of mining automation-human systems integration, as well as equipment design to reduce injury risks, manual tasks risk management, and whole-body vibration measurement and management.

Agriculture

Crop modelling

Prof. Graeme Hammer's research capabilities focus on the major cereal crops: sorghum, maize and wheat.

Graeme has expertise in crop ecophysiology and modelling, which he uses to investigate traits and management systems that have the potential to deliver productivity gains in water-limited production environments.

He leads the UQ link to the APSIM Initiative, which is responsible for the on-going development of the APSIM modelling software platform, used internationally.

His research team aims to enhance profitability and sustainability of cereal and legume cropping systems in tropical and sub-tropical environments through the integration of digital agriculture technologies and capabilities at a molecular level, whole plant, and production systems, with their frontier research in climate modelling, prediction agriculture, genetics and farming systems to provide tomorrow's decision support tools today.

Impact areas

The APSIM initiative

The Agricultural Production Systems sIMulator (APSIM) is a comprehensive model developed to simulate biophysical processes in agricultural systems, particularly as it relates to the economic and ecological outcomes of management practices in the face of climate risk.

The APSIM model can explore options and solutions for the food security, climate change adaptation and mitigation and carbon trading problem domains. APSIM has evolved into a framework containing many of the critical models required to explore changes in agricultural landscapes with capability ranging from the simulation of gene expression through to multi-field farms and beyond.

Machine learning for agriculture

Dr Anders Eriksson applies ML and deep-learning models to measure a range of plant traits pertinent to crop management and decision making.

He also helps breeders to improve plant performance through efficient computer vision techniques based on DL applied to high-resolution RGB imagery.

ML and crop performance

Innovations in plant testing in Australia (INVITA) is a $AU10M national initiative co-funded by Grains Research and Development Corporation (GRDC). INVITA leverages off a major EU initiative project - INVITE (Innovations in plant Variety Testing in Europe) and partners with Wageningen University and CSIRO. INVITA aims to improve the data provided to growers on crop varieties performance. A team led by Prof Scott Chapman is running field trials and applying sensing, UAVs and IoT sensors together with machine learning to develop analytics to improve crop performance predictions.

Crop production forecasting systems at a regional scale

Dr Andries Potgieter is an expert in the areas of seasonal climate forecasting, remote and proximal sensing with applications in the development of crop production outlooks and less risk-prone cropping systems across Australia.

His research focuses on the complex integration of remote sensing technologies, spatial production modelling and climate forecasting systems at a regional scale in agricultural settings.

Farming systems modelling

Prof. Daniel Rodriguez is a leader in the research and development of agricultural systems modelling.

Prof. Rodriguez's research team has expertise in the areas of agro-ecology, simulation analysis and modelling, agronomy, soil science and root physiology.

Their research applies systems thinking and analysis tools and is conducted in close collaboration with farmers, on farmers' fields.

His current research areas include:

- Adapting to climate and global change
- Food security and poverty mitigation across Eastern Africa
- Systems modelling and whole-farm resource allocation.

Defence

Cyber security research and digital competitiveness

The digital competitiveness of any organisation implementing Artificial Intelligence and Big Data analytics depend mostly on high-quality large datasets for training and forecasting, collected from authoritative and realistic sources.

Advanced cyber-attacks and cyber threats have the power of mutating and breaking out faster than the response of current detection models.

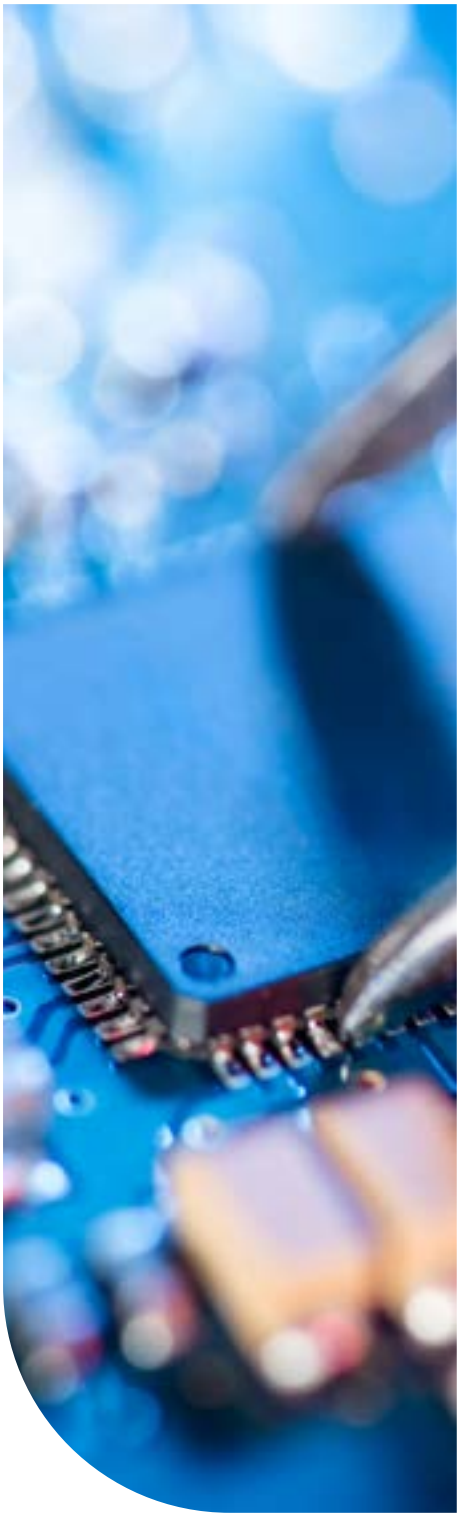
Prof. Ryan Ko and his research team use IoT security analytics; industrial control systems security analytics; network security analytics; blockchain security analytics; cloud security analytics; cyber security; and vulnerability detection to ensure that research on algorithms and approaches are state-of-the-art.

UQ's Cyber Security Research Centre and DATA61 are working together to create high-quality large cyber security datasets and explore their innovative and digital-competitiveness use.

The study will have two work packages:

- Establish a massive data collection environment to integrate datasets of normal operations, attack and defence scenarios, and APT information

Impact areas



observed across Network and Security Operation Centres (NOC and SOC) in UQ (and its global partners) and DATA61.

- Strive to push the boundary of cyber big data analytics based on the created high-quality dataset.

Using ML to detect cyber-attacks

Cyber-attacks are becoming increasingly sophisticated and frequent. The estimated average cost of each successful attack on business is already estimated at more than a $1M per incident. Dr Marius Portmann has an ongoing and successful collaboration with Comscentre to develop an advanced AI based system to detect, identify and autonomously mitigate cyber-attacks in large-scale computer networks.

As part of the collaboration, they have developed and implemented an AI platform for the detection of network intrusions and cyber attacks.

Solar panels monitoring and management

Dr Rahul Sharma's research uses AI/ML/DS technology to automatically detect and locate under-performing solar panels in large solar farms.

In particular, it uses residential loads to visualise where the spots using more energy are and where there is potential for saving through aggregate load data disaggregation techniques.

Smart energy

Power Quality Meter

Dr Richard Yan aims to apply a Power Quality Meter (PQM) system to analyse network events.

PQM captures and monitors quality data from substations and grid assets.

The project will use machine learning (ML) and AI algorithms to extract key information considered as events, and verify the event identification method on the field trial according to an established event library.

Power utilities do not have the time and capacity to analyse big data, and he is working with them on this topic to facilitate the process.

Wide-area power energy system monitoring

This research, led by Prof. Tapan Saha, relates to the cyber security of target cyber-physical system (CPS) – WAMS (Power system wide-area monitoring system) in electric power grids.

The focal point of this research is on developing ML data driven-based methods and tools to efficiently measure (through WAMS) data authentication at control centres for better data reliability and security.

Impact areas

Making PV system in distribution networks cost-effective and greener

The rapid deployment of solar photovoltaic (PV) systems in distribution networks, while indicative of the desire to move away from fossil fuels, has created new challenges due to the bi-directional power flow and power fluctuations of PV.

Professor Tapan's research team aims to provide a more cost-effective way to monitor and predict the operating conditions of the distribution network by using high-precision distribution Phasor Measurement Units (PMUs) through AI/ML/DS techniques.

Transforming big data into smart data

This research develops and uses ML techniques to automatically, extract meaningful information from existing data and transform it into domain-specific knowledge. Outcomes from this research can improve power system asset condition assessment and maintenance.

The research team led by Dr Lakshitha Naranpanawe has created a Bayesian information fusion-based algorithm, which can integrate data from field condition monitoring, maintenance records, and failure statistics to construct an inference probabilistic model to determine a health index for power system assets.

ML/AI in market design and problems analysis

ML/AI in market designs research use ML methods to construct generative models as inputs to simulation studies, especially power flow, market analysis, and design studies to solve a variety of techniques to solve problems.

In a wider context, Dr Archie Chapman develops and applies principled AI, game theory, optimisation and ML methods to solve large-scale and dynamic allocation, scheduling and queuing problems, including:

- Approximate dynamic programming, reinforcement learning and policy function approximation used to emulate decision-makers in power systems, from the bidding behaviour of generators down to residential battery scheduling by small customers

He also applies reinforcement learning to run sample efficient security and stability studies, i.e. to cut down the need to run time-domain simulations.

AI Education & Outreach

The University of Queensland has been successfully operating, innovating and engaging in the development of Artificial Intelligence for education and outreach for many years. Current outputs include:

- Corporate advice to support interaction between industry partners and UQ researchers, aiming to improve their business
- Short courses
- AI focussed undergraduate and postgraduate levels courses in computer science, data science, information technology, engineering, mathematics and business analytics.
- The research, research services and education activities around AI are complemented through coordinated community outreach and engagement activities. UQ is a founding member of the Queensland AI Hub, launched in April 2020 by the Queensland Government.
- The AI Hub provides significant avenues to raise profile and promote connections between UQ expertise, AI Hub members and the broader industry, start-ups and government organisations.
- Some of the hub activities will include advocacy; events and forums to increase awareness and understanding of AI applications; and the development and delivery of skills programs, mentoring and training activities.

Queensland AI Hub
https://www.qldaihub.com

Prof. Amin Abbosh
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Prof. Amin Abbosh is the leader of the Electromagnetic Innovations team. His main research interests include:

- Electromagnetic medical imaging systems including hardware such as microwave devices and antennas
- Design and analysis of microwave devices for wideband performance, antennas and radio wave propagation
- Computational electromagnetic, signal processing.

A/Prof. Udantha Aberyratne
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Dr Abeyratne's research interests encompass digital signal processing, machine learning, medical instrumentation, medical imaging, electrophysiology, bio-signal analysis and electronics.

Dr Abeyrath's research programs are characteristic of unorthodox approaches resulting in pioneering outcomes that produce spin-off companies and patents.

Dr Mollah Rezaul Alam
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Dr Mollah is a Postdoctoral Research Fellow. His research expertise is on characterisation of power quality events, machine learning, pattern recognition, fault detection, classification and analysis of distributed energy resources and dynamic loads impact.

A/Prof. Adrian Athique
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Dr Athique is an expert in cultural studies in Asia.
His research interests include digital media and society, transnational media in Asia, technology and economy of media systems, digital imaging and visual sociology.
He currently leads a project on digital transactions in India.

Dr Feifei Bai
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Dr Bai is an Advance Queensland Research Fellow with the UQ School of Information Technology and Electrical Engineering.

Her research interests include PV integration impacts to power grid, PMU applications in distribution networks, and fast frequency response.

Dr Mahsa Baktashmotlagh
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Dr Mahsa Baktashmotlagh's research focus is on developing ML and data mining techniques and applying them to visual data analysis, road traffic networks tools to predict congestion, prediction of neonatal sepsis and hedging foreign exchange trading risks.

Prof. Markus Barth
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Prof. Markus Barth has an ARC Future Fellowship (2014). He currently leads the ultra-high field human MR research program at the Centre for Advanced Imaging. Outcomes from his research on Magnetic Resonance Imaging (MRI) have been used to develop MRI scanner software packages used across the globe in MR labs.

Prof. Barth's research interests include:

- Understanding brain activity using functional MRI
- Memory consolidation during sleep and decoding measured functional signals (brain reading)
- Ageing and dementia using MR Neuroimaging to visually detect very small venous vessels and small bleedings in the brain
- Cardiac MR, at the ultra-high field strength of 7 Tesla to examining the anatomy and function of the human heart.

Dr Richard Bean
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Dr Richard Bean is a Research Fellow at the Centre for Energy Data Innovation (CEDI). He is an expert in the field of data science.

His research has focussed on areas as diverse as the combinatory of Latin squares and designs, statistics, power systems analysis (scheduling battery charging using energy forecasting, and reserve planning in the Australian NEM), and transport (the effect of weather and land-use on bike share demand in cities across the world).

A/Prof. Pierre Benckendorff
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Dr Pierre Benckendorff has more than 15 years' experience in education and research in the tourism field.
His research interests include visitor behaviour, tourism information technologies, and tourism education and training.

Dr Brigid Betz-Stablein
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Dr Brigid Betz-Stablein applies her statistical expertise to support a multi-disciplinary team within the Centre of Research Excellence for the study of *naevi*, (commonly known as moles), the strongest risk factor of melanoma.

The study uses multiple cameras to take simultaneous images of *naevi*, which then are stitched together creating a 3D body avatar.

It aims to use spatial-temporal models to describe the distribution of *naevi* across the 3D body surface, as well as how *naevi* change over time.

Dr Alina Bialkowski
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Dr Alina Bialkowski is a computer vision and machine-learning researcher working on applications in medical imaging and intelligent transport systems.

Her research interests are in extracting information from complex data and developing interpretable models to solve real-world problems.

She has developed deep neural networks to understand better human perception and attention in driving.

A/Prof. Mikael Boden
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Dr Mikael Boden is a computer scientist with interests in computational biology, bioinformatics, and statistical machine learning.

In bioinformatics, his research aims to develop and apply methodologies to understand and resolve a range of open problems in genomics, molecular and systems biology, including how to:

- Effectively manage the complexity of operations in genomes, and proteomes of thousands of dynamically regulated molecules
- Enable the seamless aggregation (or integration) of uncertain and incomplete data, typical of the next wave of biotechnology, across genomics, proteomics, structural biology, etc.

Dr Steffen Bollman
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Dr Steffen Bollmann's expertise in magnetic resonances has led to the development of methods to integrate multiple quantitative imaging modalities to extract hidden tissue characteristics that could potentially become early biomarkers for neurodegenerative diseases.

Dr Edgar Brea
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Dr Edgar Brea has significant experience in the design, development and implementation of information technologies, as well as expertise in organisational, sectoral and technology assessments on the impact of innovation at the industry level, and identification of commercial and corporate growth opportunities at the firm level.

He is investigating the dynamics of business models innovation and change in technology-intensive firms using exploratory data mining techniques.

Dr Christoph Breidbach
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Dr Christoph Breidbach's empirical and conceptual research addresses the fundamental question of how information technology transforms service ecosystems, and is positioned at the intersection of the Business Information Systems and Service Science disciplines.

Prof. Robin Burgers-Limerick
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Prof. Burgess-Limerick's research interests range across the broad scope of human factors and ergonomics from visual perception and movement control, through workplace interventions to prevent injuries due to manual tasks, and the design of mining equipment to reduce injury risks.

Prof. Andrew Burton-Jones
abj@business.uq.edu.au

Prof. Burton-Jones's research focuses on how effectively organisations use IT (e.g. the effective use of electronic health records in health authorities); improving methods to analyse and design IT systems (e.g. ways to improve the specification of user requirements); and improving theories and methods for researchers to use in the Information Systems discipline.

A/Prof. Nicholas Carah
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A/Prof. Nicholas Carah is an expert on digital media and cultures in the School of Communication and Arts.

His research focusses on digital and social media platforms, with a particular interest in the interplay between their participatory cultures and data-processing power; advertising models; and use of machine vision.

Dr Shakes Chandra
shekhar.chandra@uq.edu.au

Dr Chandra's expertise includes image processing, machine learning, discrete tomography and medical image analysis. He developed deformable model and machine-learning algorithms for knee deployment on the Siemens Syngo platform. His research interests are:

- Machine/Deep learning
- Making MRI faster and more affordable through better image reconstruction, processing and analysis
- Applying fractals, chaos, and number theory to image processing and computer science.

Dr Archie Chapman
archie.chapman@uq.edu.au

Dr Chapman develops and applies principled AI, game theory, optimisation and ML methods to solve large-scale and dynamic allocation, scheduling and queuing problems.

His recent research has focused on applications of these techniques to problems in future power systems, such as using batteries and flexible loads to provide power network and system services, while making the best use of legacy network and generation infrastructure.

Prof Scott Chapman
scott.chapman@uq.edu.au

Scott Chapman is Professor in Crop Physiology. He studies genetic and environmental effects on the physiology of field crops, particularly where drought dominates. He applies quantitative approaches (crop simulation and statistical methods) and phenotyping (aerial imaging, canopy monitoring, remote sensing) to understand better the interactions between the biophysical environment and genetics, growth and development on crop yield.
In recent years, Prof Chapman's research has linked with IT, engineering and maths experts at UQ to utilise digital agriculture to assist plant breeding programs.
He uses ML, deep learning and imaging processing tools to improve plant phenotyping and understand its impact on productivity.
Some of his current projects include:

- INVITA,
- An international collaboration to develop improved pipelines for deep learning analysis of farm crop images.
- Use of climate forecasting and satellite remote sensing to analyse crop types and forecast national wheat yields

Dr Cedric Courtois
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Cedric Courtois studies structural and agentic properties of (social) media-related audience practices and their consequences in a variety of contexts (e.g. the workplace, intimate relations, and civic engagement/and or participation). His research interests include algorithms, online platforms and audience research.

Prof. Stuart Crozier
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Prof. Stuart Crozier's research expertise lies in imaging technology and applications, instrumentation for physiological measurement and semi-automated diagnostics.

The commercial and academic impact of his work in Magnetic Resonance Imaging has been significant, with about two-thirds of all high-end, clinical MRI systems installed worldwide after 1997 containing patented technology co-invented and fully developed by him.

Dr Yi Cui
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Dr Cui is a Research Fellow in the UQ School of Information Technology and Electrical Engineering. His research interests include wide-area monitoring and control, data analytics and machine learning of distribution networks, condition assessment and fault diagnosis of power transformers.

Dr Alan Davidson
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Dr Alan Davidson is a lawyer and a senior lecturer in the UQ School of Business. His expertise is on the legal aspects of:

- International trade finance
- Electronic commerce
- Technology
- Privacy
- International banking
- Artificial Intelligence

A/Prof. Gianluca Demartini
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Dr Demartini's research interests include information retrieval, semantic web, and human computation.

His work focuses on improving the efficiency and effectiveness of human-in-the-loop artificial intelligence systems.

The application domains of his

research include text analytics and the intersection between structured and unstructured digital content.

He has collaborated with several industry and governmental organisations including, Facebook, Google, Microsoft, Yahoo, IBM, SAP, and The National Archives in the UK.

Dr Arindam Dey
a.dey@uq.edu.au

Dr Dey's research interests are in designing novel interfaces using both Artificial Reality, Virtual Reality, VR, and a combination of both (Mix Reality) and their application in multiple domains, including affective computing, gaming, education, health, and sustainability.

He is also interested in Empathic Computing, a research field that develops computer systems that recognise and share emotions and help people to better understand one another.

Dr Chelsea Dobbins
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Dr Chelsea Dobbins is an expert on digital health and human-computer interaction.

Her research focuses on the detection of emotions using smartphones/wearable sensors and personal informatics.

This includes areas such as lifelogging, pervasive computing, digital health, human-computer interaction, ML, mobile computing, mobile/wearable sensors, human digital memories, signal processing, and physiological computing.

Dr Chandima Ekanayake
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Dr Ekanayake's research experience and interests include condition monitoring of power apparatus, alternatives for insulating oil, performance studies of High Voltage insulators and energy related themes.

A/Prof. Anders Eriksson
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A/Prof. Eriksson is an Australian Research Council Future Fellow. His research areas include optimisation theory and numerical methods applied to the fields of computer vision and machine learning.

Prof Michael Forbes
Michael Forbes is a Senior Lecturer at the School of Mathematics and Physics. Michael does research in Operations Research and applied mathematics. His expertise covers algorithms, machine learning, linear programming, optimisation, routing and data mining, to name but a few.

A/Prof. Marcus Gallagher
marcusg@itee.uq.edu.au

Dr Marcus Gallagher's main research interests are metaheuristic optimisation and machine learning algorithms, in particular techniques based on statistical modelling.

He is also interested in biologically inspired algorithms, methodologies for empirical evaluation of algorithms and the visualisation of high-dimensional data.

Prof. Nicole Gillespie
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Prof. Nicole Gillespie's research focuses on trust development and repair in contexts where trust is challenged (e.g. after a trust failure, in complex stakeholder environments, during organisational transformation and digital disruption, in virtual healthcare and Artificial Intelligence, in cross-cultural relations).

Current research projects focus on understanding stakeholder trust in organisations and industries, organisational trust repair, designing trustworthy organisations, trust in Artificial Intelligence, and stakeholder trust and uptake of telemedicine.

Dr Mashhuda Glencross
m.glencross@uq.edu.au

Dr Mashhuda Glencross research interests are in computer graphics and human-computer interaction and include virtual/augmented reality, IoT, modelling the reflectance and structure of materials for high-quality graphics rendering and 3D scene reconstruction.

Prof. Geoffrey Goodhill
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Prof. Goodhill leads a multidisciplinary team working on how brains process information, particularly during development. This includes how growing nerve fibres use molecular cues to make guidance decisions, how map-like representations of visual inputs form in the optic tectum and visual cortex, and how these maps code sensory information.

He addresses these questions using a combination of mathematical, experimental and computational techniques.

Prof. Graeme Hammer
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Prof. Graeme Hammer researches the physiology and genetics of complex adaptive traits in field crops with a focus on water productivity in cereals.

His research underpins the development of mathematical models of crop growth, development and yield that enable simulation of consequences of genetic and management manipulation of crops in specific target environments.

A/Prof. Jim Hanan
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Dr Jim Hanan has developed mathematical, computational and visualisation approaches and techniques to facilitate the study of genetics, physiology, morphogenesis and ecology at the scale of cells and individual plants and insects.

Prof. Michael Haugh
michael.haugh@uq.edu.au

Michael Haugh is Professor of Linguistics. His research is primarily in the field of pragmatics, with a focus to date on analysing face, (im) politeness, teasing and humour, indirectness, and intention. He works with recordings and transcriptions of naturally occurring spoken interactions, as well as data from digitally mediated forms of communications, across several languages.

Prof. Ben Hayes
b.hayes@uq.edu.au

Prof. Ben Hayes' researh is in genetic improvement of livestock, crop, pasture and aquaculture species, with a focus on the integration of genomic information into breeding programs, including leading many large-scale projects which have successfully implemented genomic technologies in livestock and cropping industries.

Prof. Paul Henman
p.henman@uq.edu.au

Prof. Paul Henman's research focuses on the relationship between social policy, administration and digital information technologies.

This space includes welfare state and reform; e-government; and the administration of policies, among other.

Increasingly algorithmic government and AI is heightening concerns with government accountability and transparency, and reproduction of bias, discrimination and inequalities.

Prof. Paul W Hodges
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Paul Hodges is recognised as a world leader in movement control, pain and rehabilitation. His unique comprehensive research approach from molecular biology to brain physiology and human function has led to discoveries that have transformed understanding of why people move differently in pain. His innovative research has also led to discoveries of changes in neuromuscular function across a diverse range of conditions from incontinence to breathing disorders.

A/Prof. Helen Huang
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Dr Huang's research interests mainly include multimedia search (content understanding and analysis; video and image captioning; multimedia indesing and retrieval; near-duplicate detection; ranking and recommendation); social media analysis (event detection and monitoring; user behaviour modelling and prediction; recommender systems) and big database management.

Dr Stan Karanasios
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Dr Stan Karanasios's research focus on how organisations use, adapt, and navigate new digital technologies.

He is currently working with a leading European car manufacturer to examine ways of re-imagining work process to accommodate an increasingly digital product.

Dr Erkan Kayacan
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Dr Erkan Kayacan is a lecturer in the UQ School of Mechanical Engineering. He has been involved in the development and commercialisation of several robotic systems and was recipient of the Best Systems Paper Award at Robotics: Science and Systems (RSS) in 2018.

Dr Hassan Khosravi
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Dr Hassan Khosravi's research draws on theoretical insights from learning science and exemplary techniques from human-computer interaction, learning analytics and explainable AI, to design, implement, validate and deliver technological solutions to learner-centred, data-driven learning at scale delivery.

A/Prof. Dan (Dongseong) Kim
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Dr Dan Dongseong's research interests are in cybersecurity and dependability for various systems and networks.

Dr Jiwon Kim
jiwon.kim@uq.edu.au

Dr Kim's research is broadly in the area of modelling and analysis of intelligent transport systems (ITS) and human mobility, with an emphasis on vehicle trajectories in large-scale traffic networks and predictive analytics for real-time traffic management and operations.

His research focuses on discovering patterns and insights from massive collections of urban movement data; using data mining and ML algorithms to develop solutions to transport-related challenges in our cities.

Prof. Peter Knights
p.knights@uq.edu.au

Prof. Peter Knights' research interests are in mine maintenance management, mine operations and process control, mining simulation, mining equipment automation.

His recent work has focussed on mine data analytics and the reliability and planning issues associated with novel mining systems.

Dr Ryan Ko
ryan.ko@uq.edu.au

Prof. Ryan Ko is Chair and Director of UQ Cyber Security at the University of Queensland, Australia.

His research reduces users' reliance on trusted third parties and focusses on provenance logging and reconstruction, traceability and privacy-preserving data processing (homomorphic encryption)

Prof. Dirk Kroese
kroese@maths.uq.edu.au

Prof. Dirk Kroese's AI research involves the understanding and use of randomised (Monte Carlo) methods to help solve difficult estimation and optimisation problems in Data Science and ML. He is a pioneer of the well-known Cross-Entropy method.

Prof Paul Lever
plever@mining3.com

Prof. Lever's main research has been the theory and application of intelligent systems to earth science applications, with a particular emphasis on intelligent robotic and automated systems for dynamic environments. Other research interests include mine automation and robotics, development and implementation of software based on AI, and Computer Based Management Information and Intelligent Decision Support Systems (among others).

Prof. Xue Li
xueli@itee.uq.edu.au

Dr Xu is an expert in data. His research interests are in data mining, intelligent information systems, and social computing. The *Australian Financial Review* recognised him as one of the top 50 most powerful people in Australia in 2015.

Prof Feng Liu
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Prof. Feng Liu's research lies in medical imaging, with the focus on Magnetic Resonance Imaging hardware design and electromagnetic analysis, and cardiac electrical function imaging.

His current research program includes MRI reconstruction (parallel imaging, compressed sensing, etc.), Bioelectromagnetism, ML and Deep Learning, among others.

Prof. Brian Lovell
lovell@itee.uq.edu.au

Prof. Lovell is an expert in computer vision, machine-learning and pattern recognition methods. His research interests are in:

- Hidden Markov Model Learning Theory
- Smart Camera Technology
- Face Recognition
- Image Segmentation with Geodesic Level Sets

Dr Hui Ma
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Dr Ma's research interests include industrial informatics, power systems, high voltage engineering, wireless sensor networks, and sensor signal processing.

Prof. Greg Marston
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Prof. Greg Marston's research interests are on the social impact of AI and automation in the future of work and public policy approaches to regulating AI to reduce bias and increase transparency in algorithmic decision-making.

Dr Ben Matthews
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Dr Matthews's research focuses on the human aspects in the design and use of technology; the methods for studying it; and the involvement of people in the design processes (human-computer interaction). He has worked in a range of design domains with various industry partners imcluding: audiology (Oticon), diabetes care (Novo Nordisk), domestic Internet of Things devices, industrial components (Danfoss).

Prof. Ross McAree
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Prof. McAree's research focuses on machinery dynamics and control with a current emphasis on mining equipment automation. Prof. McAree led the development and demonstration of the world's first fully autonomous mining excavator as the outcome of a 10-year collaboration with Joy Global Surface Mining (now part of Komatsu). He has also collaborated with Caterpillar Inc. to develop and trial the world's first autonomous bulldozer capable of production dozing using the 'pivot push' method.

Prof. Geoffrey McLachlan
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Prof. Geoffrey McLachlan's research interests are in areas associated with the statistical machine learning aspects of artificial intelligence.

The most recent activities of his research team have centred on the performance of classifiers formed from partially classified data.

They have produced a number of seminal results including the apparent paradox that such classifiers can actually have lower error rates than those formed from a completely classified sample in certain cases.

Dr Alejandro Melendez-Calderon
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Dr Alejandro Melendez-Calderon has an interdisciplinary background in robotics and biomedical engineering, with extensive experience in human augmentation technologies used in medicine (robotics, wearable devices) and computational approaches to understand human neuromuscular control (unimpaired, stroke and SCI population).

Dr Melendez-Calderon's research aims to understand the principled mechanisms of human behavior, in particular related to movement control/learning and physical interaction; his technical interests are in robotics and computational modeling for medical diagnostics, assistive applications and biomedical education.

Dr Lakshitha Naranpanawe
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Dr Lakshitha is a Postdoctoral Research Fellow at the UQ School of Information Technology and Electrical Engineering. His research focuses on power transformers, modelling, condition monitoring.

A/Prof. Yoni Nazarathy
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Dr Nazarathy specialises in stochastic operations research, scheduling, optimisation, control and statistics. His expertise can be applied to agriculture, power engineering and health context.

Dr Quan Nguyen
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Dr Quan Nguyen leads the Genomics and Machine Learning (GML) unit at the Institute for Molecular Bioscience (IMB). The GML lab has been a pioneer in developing neural network models for connecting tissue morphology with molecular gene expression data for discovering in situ biological processes underlying tissue heterogeneity, focusing on cancer and genetic disease. His research uses multidisciplinary expertise in bioinformatics, genomics, systems biology, biostatistics,and machine learning to explore cutting-edge topics in genomics and transcriptomics, including analysis of some of the world's largest genomics data sets.

Dr Antonio Padilha
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During the past decade, Dr Padilha has been engaged in developing technology for the healthcare sector, particularly the design of systems for patients in rehabilitation or assistive settings.

The process involved an integration of neuro engineering techniques, robotics, control, and instrumentation to create devices and algorithms to sense and control human motion in real-time.

He aims to develop and evaluate non-invasive technology to improve rehabilitation for people with motor disabilities.

Dr Dorival Pedroso
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Dr Pedroso is an expert in numerical and computer methods for solid mechanics and materials modelling. His research focuses on computational engineering and mechanics.

A/Prof. Marius Portmann
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Dr Portmann's research interests are in the area of Computer Networks (Wireless Mesh Networks, Network protocols, Software Defined Networking, P2P Computing), Cyber Security, and blockchain technology.

Dr Andries Potgieter
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Dr Potgieter leads a team of researchers in the areas of seasonal climate forecasting at a regional scale, remote and proximal sensing with applications in the development of crop production outlooks and less risk-prone cropping systems across Australia.

Dr Amelia Radke
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Dr Amelia Radke's research lies at the juncture of science and technology, anthropology, and socio-legal studies.

Dr Radke has developed policy submissions on evaluation strategies for programs affecting Aboriginal and Torres Strait Islander peoples, along with the application of a human rights approach to emerging technologies (AI-driven) in Australia.

Dr Ash Rahimi
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Dr Rahimi's research interests fall within the fields of Natural Language Processing, Social Network Analysis and Machine Learning.

She is specifically interested in exploiting both structured and unstructured data to help machines understand the conversational language in emergency situations and health informatics.

Prof. Aleksandar Rakić
adee@eait.uq.edu.au

Aleksandar D. Rakić leads UQ's Photonics and Microwave Engineering group, focusing on the development of technologies for sensing and imaging across the electromagnetic spectrum including microwave, terahertz wave and optical systems.

The Rakić group has pioneered development of several world firsts, including laser-feedback interferometric sensors, methods based on monolithic Vertical-Cavity Surface-Emitting Laser arrays (VCSELs), blue-green lasers, terahertz quantum cascade lasers and mid-infrared interband cascade lasers.

Dr Tapani Rinta-Kahila
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Dr Rinta-Kahila is a Postdoctoral Research Fellow working in the Digital Enterprise research program at the Australian Institute for Business and Economics. His research addresses the organisational implementation of artificial intelligence and automation, the identification and prevention of technologies' negative effects on individuals and organisations, as well as the discontinuance of incumbent information technologies.

Prof. Daniel Rodriguez
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Prof. Daniel Rodrigues is a leader in agricultural systems modelling, whole-farm resource allocation.

Prof. Rodriguez's team applies systems thinking and analysis tools to crop systems.

Dr Fred Roosta-Khorasani
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Dr Fred Roosta-Khorasani is an ARC Fellow at the School of Mathematics and Physics. His research focuses on the design, analysis, and implementation of novel optimisation algorithms for training modern ML problems.

Prof. Shazia Sadiq
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Shazia Sadiq is part of the Data Science research group, Her research interests are innovative solutions for Business Information Systems that span several areas including business process management, governance, risk and compliance, and information quality and use.

Prof. Tapan Saha
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Prof. Saha is an expert in renewable energy. Some of his current research projects include:

- Solar/wind/geothermal energy integration to electricity grid
- Power systems analysis-renewable energy integration (Solar PV and wind)
- Intelligent Diagnostics of Aged Power Transformers and other ageing assests
- Electricity market analysis.

Dr Peter Scarth
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Dr Scarth has broad remote sensing skills across terrestrial and aquatic environments. His works with TERN/Auscover aims to democratise spatial data access and use, and delivering validated national and global scale products for friendly use by scientists, policy and the public.

Prof. Graeme Shanks
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Prof. Graeme Shanks works in the UQ School of Business. His research interests include ethical aspects of big data analytics, understanding how organisations benefit from AI, business analytics and enterprise architecture.

Dr Rahul Sharma
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Dr Sharma research focuses on control systems applications. This encompasses system modelling, control development and model-based fault diagnosis.

He applies his research to solar farm fault detection and diagnosis, control of grid-connected inverters, and control algorithms for demand-side management.

Dr Sally Shrapnel
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Dr Shrapnel works at the interface of causality and ML. Her goal is to infer causal relationships from different types of data, and build models that are robust with respect to interventional distributional shifts.

Her research combines theory, methodology, and applications across a broad range of disciplines.

Dr Carl Smith
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Dr Smith has expertise in Bayesian Networks, land resource management, geographic information systems, remote sensing, systems modelling and decision support systems.

Prof Simon Smith
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Wrist-worn devices (Garmin, Fitbit, apple watch, etc.) have become popular and can provide a high volume of meaningful data about everyday routines.

Prof. Smith's research team uses AI/ML approaches to classify high-frequency activities (e.g. on-road driving) from wrist-worn (actigraphy) devices aiming to bridge the biological and social sciences for community benefit.

Dr Ida Someh
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Dr Ida Asadi Someh is a research affiliate at the Centre for Information Systems Research (CISR). Her research focuses on organisational and societal impact of data, analytics and artificial intelligence.

A/Prof. Clair Sullivan
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Dr Sullivan leads the Queensland Digital Health Research Group. She is a leading Australian researcher on electronic medical records and the digital transformation of health systems.

Dr Hongfu Sun
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Dr Sun's research interests include developing novel MRI contrast mechanisms, e.g. Quantitative Susceptibility Mapping (QSM), fast and multi-parametric MR acquisitions, as well as advanced image analysis techniques, e.g. machine/deep learning, to study neuroscience and neurological diseases.

Dr Thomas Taimre
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Dr Thomas Taimre current research expertise lies in probability theory, computer simulation, and mathematical optimisation with biological and other scientific, engineering, and finance disciplines.

Dr Gayani Tennakoon Mudiyanselage
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Dr Tennakoon Mudiyanselage's research involves using health and administrative data to developing explainable ML learning models to support decision-making.

She has applied unsupervised ML methods to develop effective approaches to discover knowledge from social media networks based on user interaction patterns.

Dr Philip Terrill
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Dr Terrill's research interest is in the development of novel medical diagnostic tools and therapies to improve the health outcomes of people in Australia and globally. His current research focusses on the application of electronic instrumentation, mathematical modelling and signal's processing to paediatric and adult respiratory and sleep medicine.

Prof. Juha Toyras
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Juha Toyras is a Professor in Biomedical Engineering. His research is focused on medical devices and sensors, medical imagining, medical signal processing and connective tissue biomechanics. His work has led to patents and commercialization of scientific innovations including a forehead EEG-electrode set for emergency medicine.

A/Prof. Mark Utting
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Dr Mark Utting's research interests include software verification and AI/ model-based testing, and ML.

He is passionate about designing and engineering good software that solves real-world problems, and has extensive experience developing next-generation genomics software and manufacturing software.

Dr Atiyeh Vaezipour
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Dr Atiyeh Vaezipour's background is in Computer Interaction (HCI)/ User Experience (UX) in health and road safety research settings. Dr Vaezipour's is part of a research team aiming to:

- Develop and evaluate innovative rehabilitation technology solutions to improve the delivery and availability of evidence-based health services
- Enhance user experience and improve the interaction between end-users and technology by designing solutions tailor to the needs of individuals who undergoing a rehabilitation journey
- Design, development and evaluation of technological interventions to reduce fuel consumption and improve safe driving associated with pollution and road trauma impacts on human health.

Dr Slava Vaisman
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Dr Radislav Vaisman's research interests lie at the intersection of applied probability, statistics, and computer science and its application to theoretical and real-life problems, in the fields of machine learning, optimisation, safety, and system reliability research, among others.

Dr Vaisman has made key contributions to the theory and the practical usage of Sequential Monte Carlo methods specifically to the development of the stochastic enumeration method for estimating the size of backtrack trees.

Prof. Rhema Vaithianathan
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Prof. Rhema Vaithianathan is an expert in data analytics for social good. She has a strong interest in the use of predictive analytics to support decision making in health and human services.

Prof Vaithianathan has collaborated with hospitals and health policy agencies for more than 25 years.

A/Prof. Eric J. Vanman
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Dr Vanman's research interests include the social neuroscience aspect of emotion and intergroup prejudice. He applies several kinds of psychophysiological and neuroimaging methods in his studies.

Dr Vanman's work on unconscious bias displayed via psychophysiological measures was among few early studies that laid the groundwork for current research on implicit measures.

Recently, he has used a social neuroscience approach to study the mechanisms of empathy, including factors that might lead to a failure of empathy for others who are different to us. His new line of research examines how we really feel about robots. Can we have empathy for robots? Why do we fear them? Is it a good idea to design robots that look like humans?

Dr Sen Wang
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Dr Sen Wang's research Iinterests include medical data analysis, signal and image processing, pattern recognition and machine learning algorithms.

Prof. Janet Wiles
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Prof. Wiles is an expert in language. Her current research projects focus on human-robot interactions, language technologies, bio-inspired computation, visualisation and artificial intelligence.

Previous projects have been in complex systems modelling in biology and neuroscience, human memory, language and cognition.

Dr Ian Wood
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Dr Ian Wood's research interests are in classification, bioinformatics, stochastic optimisation, machine learning and mixture models.

A/Prof. Mohsen Yahyaei
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Dr Mohsen Yahyaei is leading the Advanced Process Prediction and Control (PPCo) program aiming to transform unit process modelling and simulation, moving from the steady-state models.

The program will develop and apply techniques to make greater use of data generated on-site and sensor technologies in combination with advanced process control, computational analytics and modelling techniques.

Dr Richard Yan
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Dr Yan is an ARC DECRA Fellow. His expertise includes distributed renewable energy integration to power grids, big data mining in power systems, and network strength and

He has collaborations with several industry partners including, Energy Queensland and Noja Power, Powerlink, and Redback (among others).

Dr Nan Ye
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Dr Nan Ye is broadly interested in algorithms, theory, and applications that involves learning from data for automated decision-making.

His research has been applied to autonomous driving, automated error detection and correction of survey data, species distribution modelling, and information extraction.

He has expertise on:

- Probabilistic graphical models
- Planning under uncertainty (focusing on partially observable Markov decision processes)
- Active learning
- Inference and learning with complex losses

Dr Hongzhi Yin
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Dr Yin's main research interests include the recommender system, social media analytics and mining, network embedding and mining, time series data and sequence data mining and learning, chatbots, federated learning, topic models, deep learning and smart transportation.

He is the current director of RSBDI (Responsible and Sustainable Big Data Intelligence) Lab.

RSBDI Lab aims and strives to develop energy-efficient, privacy-preserving, robust, explainable and fair data mining and machine learning techniques with theoretical backbones to discover better actionable patterns and intelligence from large-scale, heterogeneous, networked, dynamic and sparse data.

Dr Dongming Xu
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Dr Xu's research focuses on the understanding of how information systems are used and how information systems influence society.

She usually combines theoretical model building, laboratory and field experiments to develop prototype systems. She works on the use of social media in business and society.

She is also interested in the theoretical foundations and applications of AI to decision-making and business intelligence. In recent years, she has focused on the hi-tech start-ups development.

Dr Miao Xu
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Dr Miao Xu's research focuses on machine learning and its real-world applications.

She has applied the proposed methods to bioinformatics and computer vision problems.

Her long-term goal is to develop intelligent systems, which can learn from a massive volume of complex (e.g. weakly supervised, incomplete, noisy) data (e.g. single-/multi-labelled, ranking).

Prof. Xiaofang Zhou
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Prof. Xiaofang Zhou's research interests are in big data analytics, spatial and multimedia databases, information system integration, data quality management, and high-performance query processing.

His research focusses on finding effective and efficient solutions to managing, integrating and analysing a large amount of complex data for business and scientific applications.

Prof. Guido Zuccon
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Prof. Zuccon leads the Information Engineering Lab (ielab), a research team working in Information Retrieval and Health Data Science.

Guido's main research interests are formal models of Information Retrieval, Health Search, Formal, Models of Search, and Health Data Science. Prof. Zuccon has studied AI/ML methods to estimate the understandability of health web pages and use these to improve the retrieval of information for people seeking health advice on the web.

If you would like to know more about UQ capability in these areas or how to engage with the appropriate reseacher/s please contact:

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