

# **Curated:** Go8 Artificial Intelligence Summit 2019

















#### Photograph credits

- Page 9 Research Programmer training a deep learning model for robotic cognition
- Page 10 Software Programmer and students training Ur5sula, the robot arm, for continuous and intelligent operation
- Page 22 Unmanned Ground vehicles platooning as part of autonomous systems (Associate Professor Matthew Garratt, UNSW)
- Page 37 Scientia Professor Toby Walsh, UNSW (Photography by Grant Turner)
- Page 48 Professor Mari Velonaki, UNSW (Photography by Quentin Jones)
- Page 64 Professor Claude Sammut, UNSW (Photography by Anna Kucera)

# Contents

Introduction	4
The University of Adelaide	6
The Australian National University (ANU)	12
The University of Melbourne	18
Monash University	26
UNSW Sydney	32
The University of Queensland	44
The University of Sydney	52
The University of Western Australia	60

# Introduction

As Group of Eight (Go8) Chief Executive, I take great pride in presenting to you the curated Artificial Intelligence (AI) Capability of the eight Go8 members. It is being released in conjunction with the "Go8 AI Summit" hosted by Go8 member Monash University in Melbourne.

The Go8 is comprised of Australia's leading research-intensive universities. Seven of our eight members are ranked in the world's top 100 universities - no mean feat in a nation of just 25 million people. Only the US and the UK, on a per capita basis, can best this result.

Over 99 per cent of the Go8's research is rated as world class or above. While research is at our heart, we also provide Australia far more. With an ethos of quality and a commitment to excellence, we deliver some 100,000 quality graduates each year; the leaders of tomorrow - those who will drive and succeed in the jobs of the future.

The Go8 understands that our nation's future is inextricably linked to AI developments, especially in greater automation that can render Australia any competitive edge.

Al will drive a change process that is far more radical than even the industrial revolution. Leading research-intensive universities in developed nations, particularly in the US and China, have recognised the powerful role they play in delivering

The Australian Financial Review recently described overseas public funding as "an explosion". That this has not yet occurred in Australia has not subdued any Go8 commitment to Al. Quite the opposite.



the new Al-led economies, and the jobs and the training of the future to best harness the global value of Al.

At \$28 million over four years, the Australian Government is yet to find the level of public funding our competitor nations enjoy. The *Australian Financial Review* recently described overseas public funding as "an explosion". That this has not yet occurred in Australia has not subdued any Go8 commitment to AI. Quite the opposite.

It is stating the obvious that our Al research and industry engagement would be bolstered by more funding but the Go8 has prioritised Al with a determination not to be "left behind" for the betterment of the nation.

Al is not new – Go8 researchers have in fact been working on many aspects of Al for more than two decades. It has now become an imperative – and an exciting one rather than one to be feared; an imperative that, for the future of the Australian community, Australia must harness successfully and ethically for economic and social good.

Al *can* deliver jobs and productivity. It *can* make life easier for people. It can open up new areas of productivity and economic growth. The Go8 asserts that rather than something to be concerned about, the community deserves more understanding, and, vitally, training. Already Al technology is redefining finance, mining, health, energy and retail – to name but a few sectors. The Go8 takes pride at being at the heart of our future. Go8 AI researchers are highly respected and revered, here and overseas, making a significant global mark in the 21st Century. Indeed, all Go8 universities are undertaking research in AI and Image Processing which is rated as world class or above. The Go8 therefore has much to offer, and we work assiduously to ensure we are invaluable research partners for and with Government and industry. It is our dedicated goal to ensure Australia can reap benefits from every opportunity.

The Go8 is not reticent to say we are home to the best, and proud to be so. Being the best, striving never to be anything less, has enabled the Go8 to build solid national and International partnerships, and problem solving and advisory relationships around the world with Governments and industry.

This curated capability statement sets out who within the Go8 can help you, and what we do. It is the fourth in an ongoing series of Go8 capability statements. The Go8 has previously released Genomics, Defence and Space capability statements, all of which are available on our website.

Vicki Thomson Go8 Chief Executive

# The University of Adelaide

## The University of Adelaide contact point:

Professor Anton van den Hengel Director, Australian Institute for Machine Learning

T: +61 8 8313 5309

E: Anton.vandenHengel @adelaide.edu.au



#### **Skills and capability**

The majority of the University of Adelaide's Artificial Intelligence (AI) capability lies within the Australian Institute for Machine Learning (AIML), comprised of more than 100 machinelearning researchers. This includes eight academics, over 30 postdocs, and more than 60 PhD students and visitors.

AIML is a leader in computer vision technologies such as SLAM (simultaneous localisation and mapping), object tracking, semantic segmentation, depth estimation and the integration of vision and language capabilities in machine learning, including visual dialogue and Question Answering technologies more generally. It is ranked third in the world on publications in the top computer vision conferences in the past decade, and has won a host of international competitions

#### **Research strengths**

Strengths are in machine learning research with primary applications in computer vision, robotic vision, Visual Question Answering (VQA)



and machine learning theory. The university has made major advances that have been recognised globally in SLAM, image segmentation, 3D from 2D, Visual Dialogue and VQA and probabilistic graphical modelling theory.

The wins in many prestigious international competitions include:

- 2nd in the United States (US) Department of Defence's Defence Innovation Unit's (DIU) xVIEW Challenge (out of 4000 submissions) in 2018
- A member of the Australian Centre for Robotic Vision (ACRV) team that won the global Amazon picking challenge in 2017

The wins in many prestigious international competitions include: No 1 on REFUGE Retinal Fundus Glaucoma Challenge for the Segmentation leaderboard and also in the Segmentation of Nuclei competition in 2018

- No 1 on VQA 2.0 challenge at Conference on Computer Vision and Pattern Recognition (CVPR) 2017
- No 1 on CityScapes in 2018
- No 1 on PASCAL Visual Object Classes repeatedly
- No 1 on REFUGE Retinal Fundus Glaucoma Challenge for the Segmentation leaderboard and also in the Segmentation of Nuclei competition in 2018
- 2nd in ImageNet Scene Parsing 2016

The main industry application areas are in defence, robotic vision, driverless cars, medical imaging, agriculture, sport analytics and environmental management. Emerging areas of application include traffic management, finance, mining, smart cities and space.

AIML runs industry training and information programs to explain machine learning and artificial intelligence, and how industry can innovate using these powerful technologies.

#### **Research infrastructure**

A series of Australian Research Council (ARC) Linkage, Infrastructure, Equipment and Facilities (LIEF) grants and University investment have enabled a world-class machinelearning specific supercomputing facility labelled Phoenix. A \$1 million expansion of the system is currently underway. US Food and Drug Administration (FDA). The Automated Plate Assessment System (APAS®) is an innovative platform technology that automates culture-plate screening and interpretation. The system speeds up lab workflows and results in the faster delivery of patient results.

Speeding up the diagnosis process gives doctors more information,

In partnership with LBT Innovations, University of Adelaide research led to the development of one of the first AI medical devices approved by the US Food and Drug Administration (FDA)

#### Collaborations

The University of Adelaide has a 20-year history of strong external engagement in the AI area, particularly with defence, imaging and medical industries, and more recently in agriculture, finance, mining, space and natural resource management.

In partnership with LBT Innovations, University of Adelaide research led to the development of one of the first AI medical devices approved by the sooner. The technology could even allow country or developing-world hospitals to run their own tests without having to ship samples to a central lab, saving a huge amount of time and potentially many lives.

Industry partner Bayer CropScience is commercialising AIML image-analysis technology that is tailored to estimate the yields of potential new cereal varieties accurately, and after only very short periods of growth, to enable quick selection of the most productive lines.



Using multiple images taken from numerous angles, the technology rapidly identifies and automatically measures attributes associated with high yields. Significantly, it has been incorporated into the University of Adelaide's state-of-the-art Plant Accelerator facility, which enables thousands of test breeds to be grown simultaneously under unique and fully controllable conditions.

The potential global impact is significant. With nearly 33 per cent of the planet's arable land estimated to have been lost over the past 40 years through erosion and pollution, further increases in global average temperatures through climate change could place enormous strain on traditional crop production.

Working in an ongoing partnership with the South Australian State Government, the university is tasked with accelerating the adoption of AI into government agencies and the broader economy. In this partnership AIML is working closely with State agencies to lower costs and improve service delivery.



#### The University of Adelaide

- One project will improve and optimise traffic management systems based on the large State Government datasets collected over the past five years. AIML will use these to better understand and predict traffic flow using the latest in machine learning technology.
- Another project will develop a pastoral assessment tool to better understand and predict the impact of grazing on the dryland pastoral areas of South Australia, making improved use of satellite imagery.

This will lead to better intelligence on the condition of the State's pastoral lands and lower the costs to Government of pastoral assessment.

 AIML is also developing analytical tools to quicker identify mineral resources, and at less cost, by using the latest in machine learning technologies to analyse the worldclass datasets held by the State Government.





#### Key personnel

#### Professor Anton van den Hengel – Director AIML

Expertise in computer vision, visual dialogue, visual question answering, machine learning theory and application.

#### Professor Ian Reid – Head of School Computer Science, Theme Leader, Centre of Excellence in Robotic Vision

Research spans computer vision and machine learning, with a focus on the use of cameras as sensors for robotic applications such as autonomous vehicles.

#### Professor Chunhua Shen – Leader of the Machine Learning Group

Research interests in machine learning and computer vision; with the objective of building a visual system with human-like performance, in particular applying deep learning to object detection, text-in-the-wild detection and recognition, semantic pixel labelling, and generic image understanding.

#### Professor Anthony Dick

Researches problems in understanding images using computer vision, including the estimation of 3D shapes from images, and tracking moving objects in images.

#### Associate Professor Gustavo Carneiro

Researches the development and application of computer vision and machine learning techniques, with emphasis on medical image analysis problems.

Associate Professor Javen Shi – Director and Founder, Probabilistic Graphical Model Group; Director in Advanced Reasoning and Learning AIML

Expertise in core machine learning algorithms and theory in probabilistic graphical models, structured learning, optimisation, and deep learning. Application areas in computer vision, social networks, healthcare, smart agriculture, smart manufacturing (Industry 4.0), automated trades.

#### Associate Professor Tat-Jun Chin

Research interests in computer vision and machine learning, focusing on developing efficient algorithms for large scale optimisation problems. Application areas include 3D mapping, augmented reality, autonomous robots and self-driving cars.

#### Dr Lingqiao Liu – lecturer and ARC DECRA Fellow at School of Computer Science

Research interest in machine learning and computer vision. Current research is in deep learning, in particular zero/few-shot learning, reinforcement learning and generative models and natural language processing.

#### Dr Qi Wu – ARC DECRA Fellow and Senior Lecturer

Research interests include cross-depictive style object modelling, object detection and vision-tolanguage problems, including the problem of image captioning and visual question answering.

# The Australian National University (ANU)

#### ANU contact point:

Dr Bhavani Balakishnan Executive Officer, Innovation ANU

T: +61 2 6125 1088

E: bhavani.balakishnan@anu.edu.au



#### **Skills and capability**

ANU is an established leader in artificial intelligence (AI) research covering the full spectrum of AI specialties, including machine learning, computer vision, planning and optimisation, intelligent agents, autonomy and assurance, data mining, and knowledge representation and reasoning.

The university's academic leaders are internationally renowned experts in the fields mentioned above. They work closely with partners from academia, industry and government, and ANU offers many projects for research collaboration at all levels.

The ANU College of Engineering and Computer Science houses several research organisations, and multiinstitutional collaborations with the goal of studying and advancing the adoption of AI technologies. For example, the 3A Institute focuses on a set of critical questions around autonomy, agency and assurance for cyber-physical systems. The Australian Centre for Robotic Vision (ACRV) is leading the world in investigating the complex



challenge of applying computer vision to robotics with applications in agriculture, construction, manufacturing and infrastructure management. Other initiatives with partners, such as CSIRO's Data61, Data to Decisions Cooperative Research Centre (D2D CRC) and the Australian Renewable Energy Agency (ARENA), tackle problems in healthcare, national security, transportation, and smart energy storage and distribution. that provide new and valuable information for researchers, governments and businesses. Our research also addresses the challenge of identity crimes across a broad range of applications including e-Government portals, electronic banking, online stores and national security systems.

#### **Intelligent Agents**

Based on a mathematical model called AIXI that formalises the

Our research also addresses the challenge of identity crimes across a broad range of applications including e-Government portals, electronic banking, online stores and national security systems

#### **Research strengths**

#### Data Mining and Matching

ANU develops unique data mining and matching techniques that enable the linkage of entities such as patients or customers across large and dynamic databases, without revealing any private information. These techniques can be used to create innovative population informatics applications definition of intelligence, namely an agent's ability to succeed or achieve goals in a wide range of environment, our interdisciplinary research on intelligent agents involves machine learning, reinforcement learning, artificial intelligence, information theory and statistics. AIXI integrates numerous philosophical, computational and statistical principles including Ockham's razor, Bayes rule and Bellman equations.

#### The Australian National University (ANU)



### Knowledge Representation and Reasoning (KRR)

ANU specialises in representing and reasoning about spatial and temporal knowledge. In collaboration with other areas of expertise, such as computer vision, the university studies different applications of spatial and temporal KRR, such as sensor networks, navigation or video games. One of ANU's long-term research projects aims to develop methods for representing knowledge of physics, predicting consequences of physical actions (most of which are spatial and temporal) and selecting physical actions that have no undesired consequences. The university organises the Angry Birds

Al Competition to develop and test these capabilities in a controlled and simplified environment.

#### Machine Learning

ANU's research on machine learning – a branch of computer science that develops algorithms to help us make sense of data – is both theoretical and applied. The aim is to understand the theoretical foundations of how machines learn, their guarantees and limitations, and the relationship between different approaches to learning. The work is applied to datarich areas such as social networking, understanding and interpreting images and natural language, biomedical applications, and economic modelling.



#### Planning and Optimisation

ANU builds systems that can generate solutions to real-world planning problems in modern industry, including scheduling, intelligent control of technical systems such as power grids and biological data analysis – following the rules and achieving the best outcomes within given constraints. The research addresses automation of the reasoning required for formulating, implementing and revising plans of action, and making better use of limited resources, such as material, energy or time, and reducing waste.

#### **Computer Vision and Robotics**

ANU conducts innovative and fundamental research that enables machine to perceive the visual environment. The focus is on multiple-view geometry, 3D modelling, dynamic-scene understanding, machine learning and pattern recognition so that intelligent systems can see and understand the world as well as or better than humans can. Applications include autonomous driving, medical imaging, defence and aerospace projects, environmental monitoring, manufacturing and surveillance.



#### **Research infrastructure**

Together with government and industry partners, ANU has established and hosts several key research facilities. These include:

- The Autonomy, Agency and Assurance Innovation Institute (3A Institute)
- The Australian Centre for Robotic Vision (ACRV)
- The National Compute Infrastructure (NCI)

#### Collaborations

ANU has strong relationships across government and industry sectors.

One recent collaboration is with Reposit Power, an energy software SME, and Tasnetworks, a Distribution Network Service Provider, on grid integration of renewables, in particular the problem of coordinating consumer-owned distributed energy resources such as rooftop solar and batteries. The goals are two-fold – first, to keep the network within its constraints at minimum cost and with maximum flexibility, and second, to support the network with capacity, voltage, and frequency issues.

The CONSORT project (also known as the Bruny Island Battery trial) was led by ANU and developed what has become known as the Network-Aware Coordination (NAC) approach to this problem. The project also involved social science and computational economics research. It received four national awards and investigation is occurring into the creation of a startup to commercialise the NAC.

A follow-up project, led by the University of Tasmania with ANU as a core contributor, is now extending NAC to support batteries bidding into the Frequency Control Ancillary Services (FCAS) market whilst complying with distribution network constraints. Both projects are funded by ARENA.

Other collaborations among many others include:

 Airbus (France) on applications of automated planning and scheduling under uncertainty to a number of problems in the space and avionics sectors



- Kinova Robotics and Woodside Energy on robust robot manipulation
- The Australian Defence Science and Technology Group, CSIRO/Data61, and Oracle on the assurance of autonomous systems
- Australian Capital Territory (ACT) Government, ACT Health and Australian Institute of Health and Welfare on human-friendly machine learning for healthcare
- Northrop Grumman on contextual scene understanding.

#### Key personnel

Professor Bob Williamson Machine Learning

Professor Sylvie Thiebaux Planning and Optimisation

Professor Richard Hartley Computer Vision

Professor Rob Mahony Robotics

Professor Genevieve Bell Director of the 3A Institute (3Ai) Professor Peter Christen Data Mining and Matching

Professor Marcus Hutter Intelligent Agents

Professor Lexing Xie Machine Learning for Social and Multimedia

Professor Jochen Renz Knowledge Representation and Reasoning

Associate Professor Stephen Gould Computer Vision and Machine Learning

Associate Professor Nick Barnes Computer Vision

Associate Professor Hanna Suominen Machine Learning in Health Sciences

Associate Professor Hongdong Li Computer Vision

Dr Liang Zheng Computer Vision

Dr Patrik Haslum Planning and Optimisation

Dr Hanna Kurniawat Robotics

# The University of Melbourne

## The University of Melbourne contact point:

Professor Mark Hargreaves Pro Vice-Chancellor (Research Collaboration and Partnerships)

T: +61 3 8344 4447

E: m.hargreaves@unimelb.edu.au

#### **Skills and capability**

As a globally engaged, comprehensive research university, the University of Melbourne works closely with government and industry partners to continually challenge the status quo in artificial intelligence (AI) and to deliver use-inspired research outcomes to its stakeholders in Australia and overseas.

It places significant emphasis on progressing cross-disciplinary, translational research in emerging fields such as AI assurance, fairness and explainability; autonomous



The university also hosts the Australian Research Council (ARC) Training Centre in Cognitive Computing for Medical Technologies, a major facility for the application and development of AI technologies in health

systems and robotics; AI ethics and legal frameworks; machine learning and natural language processing; data science and statistical foundations; human collaboration with AI and cognitive science; virtual



and augmented reality; as well as applications of AI in medicine and cyber security.

The university adopts multidisciplinary approaches to AI, with involvement from researchers across areas such as Computing and Information Systems, Engineering, Mathematics and Statistics, as well as Law, Medicine and Psychology.

It has a strong track record of success with Australian Research Council (ARC) funded projects in Al and collaborates closely on Al projects with the Defence Science and Technology (DST) group. The university also hosts the Australian Research Council (ARC) Training Centre in Cognitive Computing for Medical Technologies, a major facility for the application and development of Al technologies in health.

#### **Research strengths**

#### Al Assurance Professor James Bailey

Engineering of AI systems to achieve high levels of trust. Robustness of AI systems to noise and adversarial attack. Maintenance of AI systems.

#### Al and autonomous systems Professor Chris Manzie

Distributed agent control and multi-modal autonomous systems. Networked dynamical systems and autonomous vehicles. Adaptive networks and drones.

# AI ethical, legal and societal implications

Professor Jeannie Paterson, Professor Megan Richardson, Professor Julian Webb, Associate Professor Tim Miller, Associate Professor Mark Taylor, and Dr Greg Adamson

Legal and regulatory guidelines, accountability and ethical use of AI technology, privacy implications of AI algorithms, societal consequences of AI technology.

#### Human-centric Al Professor Frank Vetere

Knowledge sharing between humans and AI systems, natural user interface technologies for interaction between humans and AI agents.

Engineering of AI systems to achieve high levels of trust

#### The University of Melbourne

#### Agent system planning and reasoning Professor Adrian Pearce

Automated programming, planning and reasoning for multi agent systems, collaboration strategies to perform complex tasks.

#### **Bionics, medical imaging and neuroimaging** Professor Anthony Burkitt,

Professor David Grayden

Al and signal processing algorithms for computational neuroscience, imaging, auditory and speech analysis.

## Computational psychology and human data

Professor Simon Dennis, Associate Professor Amy Perfors

Analysis of complex human data and behaviour, collection of human data via experience sampling, computational cognitive science and psychology.

#### Data science Professor Howard Bondell

Algorithms and statistical methodologies to analyse data,

develop insights and construct predictive models.

**Explainable and fair AI** Professor Liz Sonenberg, Associate Professor Tim Miller

Constructing interpretable AI and machine learning systems. Developing fair, accountable and transparent AI algorithms.

#### Machine learning Associate Professor Benjamin Rubinstein

Deep learning, data mining, unsupervised learning and reinforcement learning.

#### Natural Language Processing Professor Tim Baldwin, Associate Professor Trevor Cohn

Automated translation and language understanding, question answering, topic analysis, sentiment analysis, social media analysis and chatbots.

#### **Robotics** Associate Professor Denny Oetomo

Robot assisted rehabilitation, surgical robotics, advanced prosthetics, industrial collaborative robotics.



#### Sensor and information processing Professor Bill Moran

Sensor design, tracking, detection, optimal signal processing, dynamic stochastic control and networked sensor systems. Dynamic resource allocation and sensor scheduling.

#### **Spatial cognition** Professor Stephan Winter

Spatial sensing, intelligence and visualisation, spatial cognitive engineering.

#### Virtual and Augmented Reality Dr Eduardo Velloso

VR therapy for mental health, VR surgical simulation, immersive computer assisted rehabilitation, interactive spaces and media.

#### Al and Cyber Security Professor Christopher Leckie

Al for anomaly detection and identification of root-cause incidents, botnet detection, adversarial machine learning.

#### Al and Medicine Professor Wendy Chapman

Al for precision medicine, biomedical informatics, decision support, medical imaging and health data processing.

#### **Research infrastructure**

The ARC Training Centre in Cognitive Computing for Medical Technologies is developing, applying and interrogating AI applications in data-intensive medical contexts, to facilitate the next generation of datadriven and machine learning-based medical technologies. Led by the University of Melbourne, the Centre provides a world-class industry-driven training environment for PhD students and postdoctoral researchers.

Bringing together researchers in applied mathematics, statistics, mathematical physics and machine learning is the ARC Centre of Excellence for Mathematical and Statistical Frontiers of Big Data, Big Models, New Insights. Led by the University of Melbourne, it houses

#### The University of Melbourne

research programs that combine innovative methods for the analysis of data with theoretical, methodological and computational foundations, provided by advanced mathematical and statistical modelling.

At the Complex Human Data Hub researchers are developing technologies that build models of psychological processes, drawing on data from wearable sensors, Internet of Things and online social networks, and at the Academic Centre for Cyber Security Excellence, and the Oceania Cyber Security Centre are multi institutional initiatives supported by the Federal Government and Victorian State Governments engaged in research development and training in the use of AI for network security and analytics and the protection of critical infrastructure.





Enhanced Human Performance is the Australian-first state-of-the-art Virtual Reality biomechanical facility to improve the understanding of human movement and how to treat and prevent injuries, and the Centre for Clinical and Population Health

#### Collaborations

University of Melbourne researchers in artificial intelligence collaborate broadly across many disciplines, co-developing AI technologies with practitioners and researchers

While Melbourne Connect is a new purpose-built precinct of the university starting from 2020, and will be largest innovation precinct in Australia. It will bring together a critical mass of researchers and students from AI and other disciplines, housed alongside industry and government.

Informatics centralises capabilities in biomedical data analytics, information and knowledge, facilitating outcomes relating to precision medicine, participatory health and translational research.

While Melbourne Connect is a new purpose-built precinct of the university starting from 2020, and will be largest innovation precinct in Australia. It will bring together a critical mass of researchers and students from AI and other disciplines, housed alongside industry and government. from domains including medicine, engineering, agriculture, manufacturing, energy, cyber security and architecture.

The university has significant collaborations with international universities and research institutes, including University of California Berkeley, Tsinghua University and the National Institute of Informatics Japan.

The university has several deep strategic partnerships with large companies, as well as SMEs. As examples:

#### The University of Melbourne

#### **IBM Research**

Partners with the university in the ARC Training Centre in Cognitive Computing for Medical Technologies. The Centre has a five-year program focused on using AI to tackle some of the most challenging problems in healthcare. It has research streams on real-time clinical decision support, epilepsy seizure prediction, Alzheimer's prognosis and trajectory prediction and machine learning approaches for brain-computer interfaces.

#### Melbourne Accelerator Program

The university supports 10 teams each year in a startup accelerator program, providing mentoring, \$20,000 in funding, and access to a global network of advisors and investors. Participants have included:

- Black AI, a company providing an information platform for robotic automation in complex environments
- CNSDose, a personalised medicine company with software to predict medication for patients using genetic testing information

• aubot, a company developing telepresence robots.

#### **Key personnel**

#### Professor Uwe Aickelin

Computing and Information Systems, AI modelling and simulation

#### **Professor James Bailey**

Computing and Information Systems, Al assurance and machine learning

#### Professor Tim Baldwin

Computing and Information Systems, Natural language processing and AI in healthcare

#### Professor Howard Bondell

Mathematics and Statistics, Statistical data science

#### Professor Wendy Chapman

Medicine, Dentistry and Health Sciences, Al applications in health and medicine, natural language processing and medical informatics

#### Professor Simon Dennis

Psychology, Complex human data, experience sampling and cognitive science

#### Professor David Grayden

Biomedical Engineering, Computational neuroscience and bionic vision

#### Professor Saman Halgamuge

Mechanical Engineering, AI and Data Engineering



#### Professor Christopher Leckie

Computing and Information Systems, AI and cyber security

Professor Chris Manzie Electrical Engineering, AI and autonomous systems

Professor Bill Moran Electrical Engineering, Sensor and signal processing

Professor Marimuthu Palanswami Electrical Engineering, AI and the Internet of Things

Professor Jeannie Paterson Law, AI ethics, legal and regulatory frameworks

#### Professor Adrian Pearce

Computing and Information Systems, AI planning and collaboration

#### Professor Megan Richardson

Law, AI ethics, legal and regulatory frameworks

#### Professor Liz Sonenberg

Computing and Information Systems, Agent reasoning, collaboration and teamwork, explainable and fair Al

#### Professor Kate Smith Miles

Mathematics and Statistics, AI for complex systems and optimisation

#### Professor Karin Verspoor

Computing and Information Systems, Natural language processing and AI applications for health

#### Professor Frank Vetere

Computing and Information Systems, Human-centric AI, virtual and augmented reality

Professor Stephan Winter Infrastructure Engineering, Spatial cognition

Professor Julian Webb Law, AI ethics, legal and regulatory frameworks

Associate Professor Charles Kemp Psychology, Computational models of learning and reasoning

#### Associate Professor Tim Miller Computing and Information Systems, Explainable AI and AI ethics

Associate Professor Denny Oetomo Mechanical Engineering, AI for robotics

#### Associate Professor Amy Perfors

Psychology, Computational cognitive science

#### Associate Professor Ben Rubinstein

Computing and Information Systems, Adversarial machine learning, privacy

#### Associate Professor Mark Taylor

Law, AI ethics, legal and regulatory frameworks

# **Monash University**

## Monash University contact point:

Professor Jon Whittle Dean, Faculty of Information Technology

T: +61 3 9905 0511

E: jon.whittle@monash.edu



#### Skills and capability

Monash University has recently worked to centralise Artificial Intelligence (AI) research by establishing the Monash Data Futures research institute. The university, with its industry partnerships that break down traditional disciplinary barriers, and now with Monash Data Futures, fully understands that the benefits of AI and data science can only be achieved working across disciplines and sectors. Monash is working in three key areas:

- AI and data science changing governance and policy: working across the humanities and social sciences, as well as Science, Technology, Engineering and Maths (STEM) subjects, Monash is pioneering principles to ensure AI has a positive influence
- Al and data science changing health sciences: Monash has a long history of excellence in the health sciences and is now introducing Al and data science to deliver global health benefits
- Al and data science changing sustainable development:



harnessing AI and data science to deliver practical solutions at scale and with immediacy

#### **Research strengths**

By creating Australia's largest Al and data science institute, Monash is working to provide a central hub of resources that will combine

- health data
- journalism, media and communications in Al
- banking and finance consciousness
- data technology infrastructure
- AI ethics and social impact
- human-centred computing
- machine learning

By creating Australia's largest AI and data science institute, Monash is working to provide a central hub of resources that will combine deep disciplinary research with cross-disciplinary collaboration to address future technologies, social partnerships and advanced applications

deep disciplinary research with cross-disciplinary collaboration to address future technologies, social partnerships and advanced applications.

The university has existing strengths across a range of areas, including (but not limited to):

- Al regulation
- data science
- public policy
- data science in Human Arts and Social Sciences (HASS)

- cyber security
- automation
- computational intelligence
- Al applications
- data analytics
- data driven decisions

Monash's strong HASS focus uniquely positions it to drive the conversation around ethical AI and drive governance strategies and frameworks central to its advancement.

#### **Research infrastructure**

Monash has several research infrastructure facilities relevant to Al research.

Of most note is MASSIVE.

 MASSIVE is Monash's High Performance Computing for AI and Data Science. It is Monash University-led, and involves partnerships with Australia's Nuclear Science and Technology Organisation (ANSTO), within scientific data. It currently has 302 active projects and 1,187 active users and has capability across machine learning and AI software and hardware, fast parallel data processing and analytics, support for new communities, support for big-data producing instruments, and is the national leader in characterisation and data processing.

Monash also has many other Research Infrastructure Platforms that are relevant to AI research.

MASSIVE is Monash's High Performance Computing for AI and Data Science... It currently has 302 active projects and 1,187 active users

Commonwealth Scientific and Industrial Research Organisation (CSIRO), University of Wollongong, Australian Research Council (ARC) Centre of Excellence (CoE) in Integrative Brain Function and ARC CoE in Advanced Molecular Imaging. MASSIVE is a data processing and training engine for Australian science and it empowers researchers to unlock impactful research discoveries

#### These include:

Monash Bioinformatics Platform https://www.monash.edu/ researchinfrastructure/bioinformatics

Monash eResearch Centre (MeRC) https://www.monash.edu/ researchinfrastructure/eresearch

Monash Immersive Visualisation Facility https://www.monash.edu/ researchinfrastructure/mivp



#### Monash Helix https://www.monash. edu/researchinfrastructure/helix

Monash Drone Discovery Platform

Some imaging capabilities are involved in AI and Deep Learning research including:

- Monash Biomedical Imaging https://www.monash.edu/ researchinfrastructure/mbi
- Monash Micro Imaging https://www.monash.edu/ researchinfrastructure/mmi

#### Collaborations

Critical to the success of topperforming academics is collaboration – being in a network of excellence in their field, and by being able to work and publish with the best people and teams regardless of their location.

That is provided at Monash through its Data Futures research institute. It drives cross-disciplinary work, shows Monash's commitment, and assists external organisations better



#### **Monash University**

navigate the university's capabilities. Monash, assisted by its size and strong international presence has unprecedented access to big data, as well as the resource to support it. This makes Monash an ideal partner across a broad range of data science and AI topics, for example:

 A Monash research project is set to receive up to \$US14 million from the Intelligence Advanced web, to test a classification model to capture user behaviour and motivation that could be applied in law enforcement. It creates the foundation for potentially game changing research in fields such as artificial intelligence in digital forensics and law enforcement.

 Monash has partnered with Turning Point and the Eastern Health Foundation to develop a national

A Monash research project is set to receive up to \$US14 million from the Intelligence Advanced Research Projects Activity (IARPA) to develop a system to help analysts extract the most useful advice from a "crowd"

Research Projects Activity (IARPA) to develop a system to help analysts extract the most useful advice from a "crowd". This will take research and develop predictive modeling techniques and systems to assist intelligence agencies with surveillance and public safety.

 Monash is currently in collaboration with the Australian Federal Police, working to eliminate cybercriminals worldwide. Researchers conducted an extensive crawl of the dark suicide monitoring system that has the potential to set global standards for suicide prevention efforts. As part of this, Monash Professor Dan Lubman is the sole recipient in Australia of a US\$850,000 (A\$1.21 million) grant from Google to establish the world-first suicide monitoring system. The project will involve using AI methodologies to streamline coding of national suicide-related ambulance data, and help to prevent suicides.



#### Key personnel

#### Professor Phil Cohen

Natural language processing, dialogue systems, human computer interactions

#### Professor Sharon Oviatt

Computer human interaction and creativity, human-centred interfaces

#### Professor Mark Andrejevic

Digital media, surveillance and data mining

#### Professor Maria Garcia de la Banda

Constraint programming, program analysis and transformation, programming languages and bioinformatics

#### Professor Geoff Webb

Machine learning algorithms

#### Professor Tom Drummond

Computer vision, augmented reality, robotics and machine learning

#### Professor Sarah Pink – Director, Emerging Technologies Research Lab

Automation, data digital futures, emerging intelligent technologies

Professor Kris Ryan – Academic Director, Education Innovation



# **UNSW Sydney**

#### UNSW Sydney contact point:

Mr Craig Peden Senior Business Development Manager – Engineering & ICT

T: +61 432 310 348

E: c.peden@unsw.edu.au

#### **Skills and capability**

UNSW has specific AI expertise in algorithmic decision theory, robotics, embedded machine learning, computational intelligence, autonomous systems, swarm intelligence, deep learning, data science and analytics, AI empowered biomedicine, human decision science and the Ethics of AI and risk.

The university has a very applied focus on AI as a science, and it has a significant multi-disciplinary nature to the research, and partnerships with industry and government.



... as a founder of NICTA and maintains strong and active associations with Data 61

UNSW is strongly positioned to bring diverse expertise to innovative Aldriven solutions. It has participated in numerous academic, industry and government led research projects in: Telecommunications, Health and Medical, Agriculture, Mining, Transport, Oil and Gas, Defence, and Military and Space.



Specifically, UNSW academics provide expertise ranging from subjectmatter-expert advices, independent assessments and consultancy services, to the collaborative development of innovative AI solutions for specific industry applications and social needs. UNSW has had a strategic role in AI in Australia; as a founder of NICTA and maintains strong and active associations with Data 61.

#### **Research strengths**

UNSW AI related research is broadly classified as:

#### **Algorithmic Decision Theory**

Scientia Professor Toby Walsh, Associate Professor Serge Gaspers, Dr Haris Aziz, Dr Alan Blair

- Game Theory / Mechanism design
- Computational Social Choice
- Optimisation, Constraint Programming, Vehicle Routing, Resource Allocation
- Knowledge Representation and Reasoning

#### **Robotics**

Professor Mari Velonaki, Professor Claude Sammut, Professor Hussein Abbass, Professor Maurice Pagnucco

- Design
- Behaviour situational awareness, swarming and team performance
- Decision making
- Optimised navigation, collision avoidance, self-righting
- Interface design to incorporate movement, speech, touch, breath, electrostatic charge and artificial vision, supporting haptic and immersive human machine relationships

#### Embedded Machine Learning (Signal, Image and Video Analysis)

Professor David Taubman, Professor Michael Thielscher, Professor Arcot Sowmya, Professor Julien Epps, Professor Aruna Prasad Seneviratne, Associate Professor Tomasz Bednarz, Dr Vidhyasaharan Sethu, Dr Lina Yao, Dr Beena Ahmed, Dr Gelareh Mohammadi

- Speech recognition and analysis
- Image and video analysis auto classification and activity detection
- Behavioural modelling and prediction
- Speech therapy
- Human activity and mood detection
- Predicative analytics

#### **UNSW Sydney**

#### Embedded Machine Learning (Network Analytics)

Professor Vijay Sivaraman, Professor Aruna Seneviratne, Professor Mahbub Hassan, Dr Hassan Gharakheili, Dr Nour Moustafa, Dr Ben Turnbull

- Real time network health monitoring
- Auto detection of intrusions and anomalies
- Self-healing networks Embedded Machine Learning

**Embedded Machine Learning** (Internet of Things – IoT – systems) Professor Salil Kanhere, Professor Vijay Sivaraman, Professor Aruna Seneviratne, Associate Professor Wen Hu, Dr Hassan Gharakheili, Dr Lina Yao, Dr Binghao Li

- Dynamic integration and auto activity monitoring of new entrants
- Advanced biometrics and authentication
- Advanced sensor networks

#### Embedded Machine Learning (Security and Privacy)

Professor Sanjay Jha, Professor Aruna Seneviratne, Professor Julien Epps, Dr Nalin Arachchilage

- Automatic inference of user emotion and mental state
- Seamless non-intrusive monitoring

- "Breathprint" technology for continuous identification and authentication
- Identification and detection of suspicious vehicles such as drones
- Wireless situational analysis

#### Autonomous Systems

Professor Hussein Abbass, Professor Victor Solo, Professor Andrey Savkin, Associate Professor Matthew Garratt, Associate Professor Jay Katupitiya, Associate Professor Kathryn Kasmarik, Associate Professor Michael Barlow, Dr Simit Raval, Professor Travis Waller, Professor Vinayak Dixit, Professor Serkan Saydam, Professor Andrew Dempster, Professor Russell Robert Boyce

- Advanced Vehicle control including neural control, fuzzy logic and adaptive control
- Obstacle avoidance, optimised path planning, swarming, structure of motion, autonomous landing of UAVs on moving platforms
- Self-organising unmanned systems and operations
- Trusted Autonomy for Defence Applications
- Transport system visualisation and optimisation



- Autonomous mining equipment design for terrestrial and extraterrestrial operations
- Space Applications for satellite control systems, formation flying, constellation control, collision avoidance, real-time on-board satellite image processing, autoclassification and compression

#### Data Science and Analytics (Data and Knowledge Research)

Scientia Professor Xuemin Lin, Associate Professor Wayne Wobcke, Dr Michael Bain

- Data mining
- Data streams
- Distributed database systems
- Spatial database systems
- Web databases
- Social media analysis and recommender systems

#### Data Science and Analytics (Bayesian and computational statistical modelling)

Professor Scott Sisson, Associate Professor Yanan Fan

- For modelling uncertainty, including approximate Bayesian computation
- Bayesian deep learning, computationally intractable models,

large and complex datasets, synthetic likelihoods, symbolic data analysis and variational inference

#### **Data Science and Analytics** (**Optimisation**) Dr Guoyin Li

 Optimisation methods for machine learning, including optimisation under data uncertainty, support vector machine, sparse optimisation, large scale optimisation

#### Data Science and Analytics (Optimisation)

Professor Josef Dick

 Computational Mathematics

 Function approximation on neural networks; neural networks in uncertainty quantification; quasi-Monte Carlo methods, data compression

#### Al empowered Biomedicine

Dr Fatemeh Vafaee, Dr Liao (Leo) Wu, Scientia Professor Nigel Lovell, Professor François Ladouceur

- Deep learning for human disease genomics, single-cell molecular data analysis, and drug discovery
- Optimisation and machine learning across major high-throughput data for prediction of disease prognosis,

#### **UNSW Sydney**

diagnosis and therapeutic response, i.e., personalised medicine

- Deep Learning for personalised health monitoring and personalised nutrition
- Network medicine and systems biology
- Flexible and intelligent robotic systems for surgical applications
- Brain Computer Interface (BCI)

   deep learning for decoding brain activities and enabling device control, design of novel physical networks for BCI

#### **Human Decision Science**

Scientia Professor Bernard Balleine, Professor Julien Epps, Professor Lemuria Carter, Associate Professor Dani Navarro, Dr Ting Yu, Dr Chris Donkin

- Human Decision Science computational modelling, human teaming with autonomous systems, behavioural, mood and mental state prediction with matched optical instrument design (human computer interface optimisation)
- Predictive human behaviour modelling

 AI based recurrent neural networks

 assessment of temporal dynamics in brain function and predictive diagnosis of psychiatric conditions

#### AI Ethics and Risk

Scientia Professor Toby Walsh, Professor Lyria Bennett Moses, Associate Professor Helen Dickinson, Dr Jai Galliot, Dr Thomas Keating

 Research towards Ethical, legal and political issues associated with the employment of emerging technologies, including robots, autonomous vehicles, cyber systems and soldier augmentation technologies

#### **Research infrastructure**

UNSW researchers and their collaborators have access to inhouse and external infrastructure to complement their research themes in AI. Examples of such facilities are below:

 UNSW hosts the National Facility for Human-Robot Interaction Research, which is purposedesigned to host a wide variety





of experiments investigating how people interact with technological devices, including robots. Stateof-the-art sensors are concealed in the experiment space allowing unobtrusive measurement of human physical attributes such as location and limb position. Internal states such as effect and intent can then be inferred from the physical measurements. The streams of time-stamped data can then selectively be logged and/or used in real time to control technological devices in the experiment space<sup>1</sup>.

- UNSW hosts one of the largest indoor testing facilities for Unmanned Autonomous Systems. The facility is equally used for modelling human performance and capturing human motion. It includes a large collection of unmanned aerial vehicles, unmanned ground vehicles, and unmanned helicopters. This facility is instrumental in supporting the research themes of Autonomous Systems and Trusted Autonomy.
- UNSW's Expanded Perception and Interaction Centre – EPICentre –

1 https://hri.edu.au/about/

#### **UNSW Sydney**

represents the next generation in imaging technologies, engineering, high-performance visualisation, simulations and applied artificial intelligence. This ground-breaking new interdisciplinary Centre applies integrated design thinking and interdisciplinary approaches to research to enable scientists to see their research data in real time and three dimensions via a unique blend of 3D interactive environments supported by a cutting-edge computing infrastructure. EPICentre's major research facilities are accessible to UNSW and external researchers and collaborators from industry and government. The staff of the Centre provide research collaboration, technical support, education and training to researchers accessing the facilities<sup>2</sup>.

 UNSW hosts a human performance and distributed simulation laboratory with state-of-the-art infrastructure for multi-modal sensors to assess human performance in real-time using data sources such as EEG, voice, video, mouse movements, keyboard logging, and vibrations. The laboratory is also licensed to operate a suite of commercial software for personnel training and education. This laboratory supports research in Autonomous Systems, Human Decision Science and Human Computer Interface Optimisation.

 Machine Learning and AI research require significant computational power. In addition to UNSW's own High Performance Computing (HPC) clusters, the university is an active member of the National Computational Infrastructure (NCI) – the nation's most highlyintegrated, high-performance research computing environment<sup>3</sup>.

#### Collaborations

Enabling Academic and Industry connection to drive positive societal change is a core focus at UNSW. UNSW both encourages and facilitates partnering with industry

2 https://artdesign.unsw.edu.au/research/epicentre-expanded-perception-interaction-centre

3 https://nci.org.au/



and government through contract and collaborative research, consulting and short courses. Examples of such AI industry collaborations include:

 Planning what Australia's defence force should be in 10-30 years is a difficult task for the ADF, entails the expenditure of tens of billions of dollars and directly determines Australia's future national security. Uncertainty, changing technology, the multi-faceted complexity of modern and future warfare are key factors in the task's difficulty. UNSW researchers are partnered with Defence Science and Technology (DST) in the Modelling Complex Warfighting (MCW) strategic initiative. This provides empirical, evidence based and tailored advice to analysts and senior decisionmakers in the ADF. Using simulation upon High Performance Computing as a foundation. AI and visualisation quide the exploration of the hyperdimensional search space of possible futures, force structures and operating concepts. The AI employs storytelling techniques to synthesis and structure the huge volume of simulationgenerated data into insights and recommendations on future force structures.

- Tip Top Bakeries needed to optimise its delivery network to improve efficiency and save on last mile logistic costs. Approximately 80 per cent of Tip Top's transport costs are incurred on last mile logistics. UNSW researchers developed a 'Cost to Serve Solution', which uses artificial intelligence software and optimisation algorithms to streamline the overall delivery system. The organisation cut more than one million kilometres of annual road travel, which helped reduce costs and resulted in a significant reduction in its greenhouse gas emissions.
- Detection of cancer in a minimally invasive manner is considered the holy grail for cancer diagnostics. A key challenge is the computational identification of optimal biomarker panels from such liquid biosources. UNSW researchers have partnered with an Australian-based company on blood-based screening of breast cancer to develop an advanced AI protocol utilising machine learning

#### **UNSW Sydney**

models which identify optimal molecular biomarkers from highthroughput profiling of patients' blood samples. It is anticipated that this research will enable accelerated diagnosis.

#### Key personnel

#### **Algorithmic Decision Theory**

Scientia Professor Toby Walsh – Professor of Artificial Intelligence Al Algorithmic Decision Theory, Robotics, Al Ethics

Associate Professor Serge Gaspers AI, Algorithmic Decision Theory

Dr Haris Aziz Al, Algorithmic Decision Theory

Dr Alan Blair Al, Algorithmic Decision Theory, Machine Learning, Robotics

#### **Robotics**

Professor Mari Velonaki AI, Robotics, Social Robotics

#### Professor Claude Sammut

Al, Robotics, Machine Learning

#### Professor Hussein Abbass

Al, Robotics, Autonomous Systems, Trusted Autonomy, swarming

#### Professor Maurice Pagnucco

Al, Robotics, Reasoning

#### Professor Shan-Ling Pan

Al, Artificial intelligence in healthcare robots, digital enablement within the contexts of business and social innovation

#### Associate Professor Matthias Haeusler

Al, construction robotics, sensors, machine learning, computation and big data

#### Dr Mark Whitty

Robotics, Image Processing, horticultural sensing

Dr David Rajaratnam AI, Robotics, Reasoning

#### Dr Johnson Xuesong Shen

AI, construction robotics

#### Embedded Machine Learning -Signal, Image & Video Analysis

Professor David Taubman

Al, Embedded Machine Learning, Signal, Image & Video Analysis

#### Professor Michael Thielscher

Al, Embedded Machine Learning, Signal, Image & Video Analysis

#### Professor Arcot Sowmya

Al, Embedded Machine Learning, Signal, Image & Video Analysis, pattern recognition, data mining



#### Professor Julien Epps

AI, Embedded Machine Learning, Signal, Image & Video Analysis, pattern recognition, data mining, cybersecurity, human decision science, mood and mental state prediction

#### Professor Aruna Seneviratne

AI, Embedded Machine Learning, Signal, Image & Video Analysis, pattern recognition, data mining, data security, Network Analytics, Intelligent IoT Systems, Cybersecurity

#### Associate Professor Tomasz Benarz

AI, Embedded Machine Learning, Signal, Image & Video Analysis, data visualisation

#### Dr Vidhyasaharan Sethu

AI, Embedded Machine Learning, Signal, Image & Video Analysis, Pattern Recognition, Knowledge Representation and Machine Learning

#### Dr Lina Yao

AI, Embedded Machine Learning, Signal, Image & Video Analysis, Pattern Recognition and Data Mining, Intelligent IoT

#### Dr Beena Ahmed

AI, Embedded Machine Learning, Signal, Image & Video Analysis, Knowledge Representation, Pattern Recognition and Data Mining

#### Dr Gelareh Mohammadi

AI, Embedded Machine Learning, Signal, Image & Video Analysis, Computer-Human Interaction

#### Embedded Machine Learning - Network Analytics and Intelligent IoT

#### Professor Vijay Sivaraman

AI, Embedded Machine Learning, Network Analytics, Intelligent IoT Systems, cybersecurity

#### Professor Mahbub Hassan

AI, Embedded Machine Learning, Network Analytics, Intelligent IoT Systems, cybersecurity

#### Professor Salil Kanhere

AI, Embedded Machine Learning, Network Analytics, Intelligent IoT Systems, data security, cybersecurity

#### Associate Professor Wen Hu

AI, Embedded Machine Learning, Network Analytics, Intelligent IoT Systems, Cybersecurity, Secure wireless transmission and positioning

#### Dr Hassan Gharakheili

AI, Embedded Machine Learning, Network Analytics, Intelligent IoT Systems, cybersecurity

#### Dr Nour Moustafa

AI, Embedded Machine Learning, Network Analytics, Intelligent IoT Systems, Cybersecurity

#### Dr Ben Turnbull

AI, Embedded Machine Learning, Network Analytics, Intelligent IoT Systems, conceptual modelling and testing

#### Dr Binghao Li

AI, Embedded Machine Learning, Network Analytics, Intelligent IoT Systems (Industrial), Secure wireless transmission and positioning

#### **UNSW Sydney**

### Embedded Machine Learning - Security and privacy

#### Professor Sanjay Jha

AI, Embedded Machine Learning, Network Analytics, Intelligent IoT Systems, data security, cybersecurity

#### Dr Nalin Asanka Gamagedara Arachchilage

Al, Trust, cybersecurity, software engineering

#### Autonomous Systems

#### Professor Victor Solo

Al, Autonomous systems, Adaptive Signal Processing and Control, computer vision

#### Professor Andrey Savkin

AI, Autonomous systems, Coordination and Control of Mobile Robots

#### Associate Professor Matthew Garratt

Al, Autonomous systems, Intelligent control of autonomous systems, Fuzzy logic, neural networks, machine vision

#### Associate Professor Jay Katupitiya

Al, Autonomous systems, control systems, manufacturing robotics

#### Associate Professor Kathryn Kasmarik

Al, Autonomous systems, Autonomous mental development for machines, particle swarm optimisation

#### Associate Professor Michael Barlow

Al, Autonomous systems, multi-agent systems, machine learning, human computer interaction, speech science and technology

#### Professor Travis Waller

Al, Intelligent Transport system design, real time journey time prediction, mathematical modelling of transport systems

#### Professor Vinayak Dixit

AI, Intelligent Transport system design, real time journey time prediction – travel time uncertainty

#### Professor Serkan Saydam

Al, Autonomous mining and industrial systems – terrestrial and extra-terrestrial, mineral price prediction

#### Dr Simit Raval

Al, Autonomous UAV's for surface and underground mining analysis

#### Professor Andrew Dempster

Al, Autonomous systems, Adaptive Signal Processing and Control, computer vision, Space Applications, Satellite control and communications

#### Professor Russell Robert Boyce

Al, Autonomous systems, Adaptive Signal Processing and Control, computer vision, Space Applications, aerospace engineering

#### **Data Science and Analytics**

#### Scientia Professor Xuemin Lin

Al, data mining, data streams, distributed database systems, spatial database systems, web databases

#### Professor Scott Sisson

AI, Bayesian and computational statistical modelling, deep learning, variational inference



#### Professor Josef Dick

AI, Computational Mathematics, Function approximation on neural networks; neural networks in uncertainty quantification

#### Associate Professor Yanan Fan

AI, Bayesian and computational statistical modelling, deep learning, variational inference

Dr Guoyin Li Al, Optimisation methods for machine learning

#### Associate Professor Wayne Wobcke

AI, Computational social science, recommender systems, intelligent agents

#### Dr Mike Bain

AI, recommender systems, knowledge representation, machine learning

#### AI Empowered Biomedicine

#### Scientia Professor Nigel Lovell

AI, Brain Computer Interface, Telemedicine& Medical informatics; Computer data acquisition& database design; biomedical instrumentation

#### Professor François Ladouceur

AI, Brain Computer Interface, photonics, optoelectronics

#### Dr Fatemeh Vafaee (VafaeeLab.com)

AI, Systems biology, bioinformatics, deep learning for disease diagnosis, image processing

#### Dr Liao (Leo) Wu

Al, robotics for surgical applications

#### **Human Decision Science**

Scientia Professor Bernard Balleine AI based recurrent neural networks

#### Professor Lemuria Carter

AI, Decision science, prospect theory

#### Associate Professor Dani Navarro

Al, computational modelling, human teaming with autonomous systems, behavioural, mood and mental state prediction

Dr Ting Yu AI, use of AI in service delivery

Dr Chris Donkin AI, Predictive human behaviour modelling

#### **AI Ethics**

#### Professor Lyria Bennett Moses Al and technology related legal matters

Professor Peter Leonard AI ethics, data ethics

#### Associate Professor Helen Dickinson

AI, ethical and legal implications of expanding the use of AI in social and care robots

#### Dr Jai Galliot

AI, ethical, legal and political issues associated with the employment of emerging technologies

#### Dr Thomas Keating

Al, engages with problems involving human-technology relationships

# The University of Queensland

#### The University of Queensland contact point:

Professor Mohan Krishnamoorthy Pro-Vice-Chancellor, Research Partnerships

T: +61 7 336 53559

E: pvcrp@research.uq.edu.au

Associate Professor John Williams Innovation Partnerships

T: +61 7 336 58834

E: j.williams1@uq.edu.au



#### Skills and capability

The University of Queensland's (UQ) numerous research and collaborative strengths, with capability across multiple faculties and institutes, extends from fundamental mathematical and computer sciences in Artificial Intelligence (AI) and machine learning algorithms and architectures; including with broader social implications such as ethics and trust, regulation and governance, future of work, and business and economic transformation.

Within applied and translational research, applications are tackled across a broad spectrum of domains including quantum computing, agriculture, health and autonomous systems. UQ is engaged with the Defence Cooperative Research Centre (CRC) for Trusted Autonomous Systems, in both technical and nontechnical projects.

In the emerging frontier of neuroscience-inspired AI, the Queensland Brain Institute (QBI) at UQ is host to world-leading capability in functional neuroscience and understanding computation in biological nervous systems.



#### **Research strengths**

#### Fundamentals

Professor Geoff McLachlan, Dr Guido Zuccon, Dr Fred Roosta-Khorani

UQ's Schools of Mathematics and Physics, and Information Technology and Electrical Engineering work together on the mathematical, statistical and computer science fundamentals that underpin advances architectures that will be required for the next generation of AI.

## AI algorithms, architectures and applications

Professor Janet Wiles, Professor Brian Lovell, Professor Ross McAree, Associate Professor Marcus Gallagher, Dr Guido Zuccon

The School of Information Technology and Electrical Engineering is engaged

In the emerging frontier of neuroscience-inspired AI, the Queensland Brain Institute (QBI) at UQ is host to world-leading capability in functional neuroscience and understanding computation in biological nervous systems

in AI and machine learning, and the broader data science that supports these technologies.

#### Functional Neuroscience, Biologically-inspired AI

Professor Srini Srinivasan, Professor Linda Richards, Professor Geoff Goodhill, Professor Markus Barth

The Queensland Brain Institute is a world leader in research to understand the fundamental workings of the brain and translating those insights into biologically-inspired with discipline experts from across the University and industry and research partners, in the application of AI to a wide range of applications from Defence and AgTech to mining automation and genomics.

**Trust, policy, governance** Professor Nicole Gillespie, Associate Professor Rain Liivoja

Trust is central to the acceptance and adoption of AI, as well as citizens' willingness to share their data. Yet AI poses several significant challenges to trust that stem from the potential and perceived risks it poses to society, its novelty and uncertainty, as well as inherent characteristics, such as the difficulty of explaining 'black box' machine learning. This program of research focuses on understanding stakeholder trust in AI applications, the design of trustworthy AI, and the governance and regulatory mechanisms required to support trustworthy AI.

#### Social impacts

Professor Janet Wiles, Associate Professor Paul Henman, Associate Professor Andrew Crowden

Deployment of AI and autonomous decision-making systems in commercial, government, welfare and educational realms, creates a range of challenging legal, ethical and regulatory challenges, and potential negative social, cultural and economic consequences. In addition to long-standing issues of privacy, data protection and surveillance, the use of AI generates concerns around increased social and economic inequalities, reproducing and exacerbating discrimination and social biases (by ethnicity, gender etc), promoting extremist views and fake news, and transparency and openness.

UQ researchers are working with government and industry to develop new analytical frameworks and organisational arrangements for ethical and responsible AI. The updating of legal and regulatory frameworks to encompass rapidly emerging technologies is also being investigated. Technical tools that enable the development and assessment of ethical AI are being built. Research is being undertaken to better understand the personal experience of AI based decision making.

#### **Research infrastructure**

UQ's Research Computing Centre hosts the Wiener cluster, a Dell EMCmanufactured high-performance computer (HPC) designed to expedite the pace of research in a diverse range of imaging-intensive science, generated by UQ's world-leading microscopy facilities.

Wiener supports next-generation molecular biology, neuroscience and



translational research at UQ, and is also available for broader AI and machine learning research projects that require massive neural-network compute capability.

The Weiner cluster harnesses the capabilities of NVIDIA high performance graphics processing units (GPUs), and is engineered for very specific use cases. It is built for applications that use GPU accelerated codes (CUDA, OpenCL, OpenACC) on NVIDIA architectures which are the de-facto standard in high-performance machine learning research and development.

Wiener consists of 34 Dell EMC PowerEdge R750 and C4140 28-core nodes featuring up to a terabyte of RAM each, and multiple NVIDIA V100 GPU accelerator units (100 total) interconnected with 100 gigabit/ second Infiniband networking, providing a total of seven terabytes/ second bandwidth at 90 nanosecond latency.



#### The University of Queensland

A next-generation 100 gigabyte/ second BeeGFS data storage system can feed data to accelerator network with minimal latency. Wiener's overall computational capacity is approximately 4.3 petaflops (floating point operations per second).

The UQ Advanced Microscopy Facility supports QBI's advanced neuroimaging with several pieces of key infrastructure. The facility's capabilities allow 3D imaging of whole brains through to sub-cellular structures within neurons with techniques such as single-photon/two-photon scanned light-sheet microscopy, structured illumination microscopy (SIM), single-molecule localisation microscopy (PALM/STORM/sptPALM), single-molecule reconstruction and tracking, spinning disk confocal microscopy, laser-scanning confocal and two-photon microscopy, fluorescence lifetime imaging microscopy (FLIM), fluorescence recovery after photobleaching (FRAP),





calcium imaging, stereology and automatic slide scanning. Many of the instruments have been designed to allow imaging of live neurons and organisms to allow the study of dynamic processes related to neuroscience research.

UQ is a lead node in the National Collaborative Research Infrastructure research institutes, industry organisations and government bodies with whom it share values and can benefit from complementary expertise and resources.

UQ's Partner Engagement Framework supports these efforts and drives the university's approach to streamlined, targeted engagement with strategic

UQ is a lead node in the National Collaborative Research Infrastructure Strategy (NCRIS) National Imaging Facility (NIF) which supports functional neuroscience research

Strategy (NCRIS) National Imaging Facility (NIF) which supports functional neuroscience research. The university's leadership in the Research Data Services (RDS) facilitates managed access to massive datasets required for advanced AI and machine learning projects. UQ is also a partner in the NCRIS National Computing Infrastructure (NCI).

#### Collaborations

Integral to creating global impact is UQ's collaboration with an international network of universities, partners. UQ's outreach is greatly strengthened and extended through its offshore presence comprising UQ representatives and physical offices in key markets.

In Defence the university is working with the Defence CRC for Trusted Autonomous Systems on technical and non-technical programs, including the investigation of the ethics and law of autonomous systems, including clarifying legal and ethical constraints, and the ways that autonomy can enhance compliance with law and social values (with UNSW). Also, the

#### The University of Queensland



development of AI models for the visual detection and classification of inputs relevant to combat in urban and rural environments both in daylight and while using night vision.

In Health there is digital pathology with Sullivan and Nicolaides Pathology (the system is now fully operational and delivering operational savings) and the Fusion of Natural Language and Medical Images also with Sullivan and Nicolaides Pathology.

In addition, the university is collaborating with Queensland Health on AI applications such as information retrieval and analysis for integrated electronic medical records (ieMR); for clinical decision support and outcome prediction using machine and deep learning, for computer vision applications in medical imaging such as dermatology (melanoma detection) and natural language processing for language translation in clinical care delivery.

In the areas of environment and learning UQ is monitoring commercial fishing with Fish-e for Qld Department of Fisheries; developing AI solutions with Australian Laboratory Systems for industrial and environmental testing; monitoring corrosion on electrical distribution towers from helicopters and drones with Powerlink and detecting and counting animals in National Parks for Queensland's Department of Environment and Science.



#### Key personnel

#### Professor Janet Wiles – School of Information Technology and Electrical Engineering (ITEE)

Human/Al/robotic interactions, bio-inspired computation, visualisation, complex systems modelling, language and cognition

#### Professor Brian Lovell – ITEE

Image processing and analysis, content-based retrieval, visual tracking and object detection/ recognition

#### Professor Linda Richards AO – QBI

Functional neuroscience, brain development

#### Professor Nicole Gillespie – UQ Business School (UQBS) Stakeholder trust in AI; developing trustworthy AI

#### Professor Srini Srinivasan - QBI

Biologically-inspired visual processing, machine vision and robotics

#### Professor Geoffrey McLachlan – School of Mathematics and Physics (SMP)

Classification, image analysis, machine learning and pattern recognition

#### Professor Geoffry Goodhill – QBI

Computational neuroscience

#### Professor Ross McAree – School of Mechanical and Mining Engineering (SoMME) Autonomous systems and mining automation

#### Professor Markus Barth – ITEE

Cognitive neuroscience, functional neuroimaging

#### Associate Professor Margie Wright – QBI

Cognitive neuroscience, neuroimaging

#### Associate Professor Marcus Gallagher – ITEE

Nature-inspired problem solving and optimisation, metaheuristics, evolutionary computation, machine learning, exploratory data analysis and visualisation

#### Associate Professor Rain Liivoja

Law, ethics, trust and law relating to autonomous defence systems

#### Associate Professor Paul Henman

#### - Centre for Policy Futures

Social and ethical concerns and impacts of AI, policy and governance frameworks for automated decision

#### Associate Professor Anders Eriksson – ITEE

Computer vision, optimization theory, machine learning

Dr Guido Zuccon – ITEE Natural language processing, information retrieval

Dr Ida Someh – UQBS Organisational and societal impact of AI

# The University of Sydney

## The University of Sydney contact point:

Professor Duncan Ivison Deputy Vice-Chancellor (Research)

E: duncan.ivison@sydney.edu.au

Associate Professor Eric Knight Pro Vice-Chancellor (Research – Enterprise & Engagement)

E: eric.knight@sydney.edu.au

Katie Richmond External Engagement Manager

E: katie.richmond@sydney.edu.au



#### **Skills and capability**

The University of Sydney conducts world-leading research and development in artificial intelligence (AI), computer vision image processing, machine learning, robotics and intelligent systems, in partnership with industry and government.

Developments are driven from dedicated research clusters; UBTECH Sydney Artificial Intelligence Centre, the Australian Centre for Field Robotics, and the Institute of Biomedical Engineering and Technology, and are supported by state-of-the-art infrastructure and facilities.

#### **Research strengths**

#### Artificial Intelligence

In partnership with a world-leading robotics company, the UBTECH Sydney Artificial Intelligence Centre brings together a multidisciplinary team of award-winning researchers advancing AI to endow machines with the capabilities of perceiving, learning, reasoning and behaviour. Pioneering



work is currently being undertaken in the areas of:

- Facial recognition
- Image processing
- Label noise learning

#### Autonomous and Intelligent Systems

The Australian Centre for Field Robotics (ACFR) partners with industry and government to deliver innovative autonomous and robotic systems to solve complex societal challenges. ACFR offers a number

- Control and optimisation of dynamic systems
- Intelligent transport
- Marine systems autonomous underwater vehicles
- Security and defence

#### Machine Learning

The university is applying machine learning techniques to address a range of real-world inference problems in physical, life and social science areas, as well as to the discovery process in natural science.

In partnership with a world-leading robotics company, the UBTECH Sydney Artificial Intelligence Centre brings together a multidisciplinary team of award-winning researchers advancing AI to endow machines with the capabilities of perceiving, learning, reasoning and behaviour

of world-leading technical solutions, research and expertise in six key thematic areas:

- Pioneering robotics and AI in agriculture
- Innovating medical devices and capabilities for improved health

The Centre for Translational Data Science develops novel machinebased applications for intelligent systems including robotics, predictive maintenance and process control.

The School of Aerospace Mechanical and Mechatronic Engineering uses machine learning in the development

#### The University of Sydney

and fueling of Unmanned Aerial Vehicles.

The University of Sydney Nano Institute develops probabilistic machine learning methods for big data problems and complex systems to be used as frameworks for representing and manipulating the uncertainty about data and future consequences of actions in Al.

The School of Electrical and Information Engineering has developed new machine learning methods for various vision and big data analytics related applications.

#### Communication

The Centre for IoT and Telecommunications is pioneering a theoretical framework and technologies for ultra-reliable low latency communications which would enable automation of critical infrastructure, industrial control in factories, the deployment of self-driving vehicles and tele-robotic surgery. Researchers are advancing industry-supported wireless communication and networking research, focusing on new areas including 5G mobile, Internet of Things, signal processing for communication,





advanced coding and quantum imaging.

#### Social impact

The Centre for Robotics and Intelligent Systems: Science and Society, researches the social, ethical, legal and economic implications of robotics and intelligent systems, particularly in areas of transportation, health and medicine, the environment, The Sydney Informatics Hub centralises the university's capabilities in data analytics, modelling, bioinformatics and highperformance computing with the Artemis 3 supercomputer. It also houses capabilities in information/ data engineering that power leading research in AI, machine learning, cyber security and integrated/ distributed digital platforms.

Researchers are advancing industry-supported wireless communication and networking research, focusing on new areas including 5G mobile, Internet of Things, signal processing for communication, advanced coding and quantum imaging.

primary industries, emergency services, the workplace and home.

The Socio-Tech Futures Lab examines the ways in which social, cultural and political dynamics influence the integration of automation, AI, and robotics into everyday life.

#### **Research infrastructure**

The University of Sydney's research infrastructure includes a number of high-end facilities to support Al research. While at the Australian Centre for Field Robotics there are major facilities for development of autonomous systems including air, ground and subsea robots. The Field Robotics Laboratory includes a wellequipped electronics fabrication and assembly area, near-field and far-field anechoic test facility, environmental test chamber, individual robot assembly and testing bays, a flightvehicle fabrication laboratory and a mechanical workshop.

#### The University of Sydney



The Unmanned Aerial Vehicle Laboratory is equipped with rapidprototyping tools and facilities to develop novel flight systems and support flight operations, and the Sydney Propulsion Lab focuses on hybrid fuel-cell based propulsion systems and small variable pitch propellers to advance drone propulsion technologies. The lab houses a range of state-of-the-art test facilities to conduct component, scale-model, and system-level tests of electric propulsion hardware at any technology readiness level. At the TRACSLab there is a unique laboratory with connected driving simulators which can analyse travel choice and driving behavior, and the impact of Automated Vehicles.

The new Advanced Manufacturing and Materials Processing Research Facility focuses on the development and application of new materials, forward deployed manufacturing, consolidated parts prototyping, manufacturing and repair, integrated digital platforms, distributed systems security, AI and automation.



And the University of Sydney Nano Institute allows for fabrication of devices and structures with features on the micro and nanoscale, with specialised tools and processes to enable researchers and industry to make nanodevices and prototype new ideas in optical chips, photonics, autonomous systems, surveillance, electronic devices and new quantum science and technology.

The Centre for Distributed and High-Performance Computing increases collaborative opportunities for researchers by providing a focal point for research that spans several disciplines, including algorithms, big data analytics, databases, green computing, data centres and clouds, networking, the Internet of Things and service science.

#### Collaborations

The University of Sydney has a long tradition of innovation and engagement with industry, government and community partners. Examples of the university's existing partnerships across a range of Al related research activities include:

#### Qantas Partnership for Future Flight Planning System

The University of Sydney's Australian Centre for Field Robotics leads the development of flightplanning systems that will help the airline fly optimised routes, reduce fuel consumption and improve operational effectiveness. It is assisting pave the way for greater operational efficiency and



#### The University of Sydney

supporting greener commercial aviation. Research has focused on how aerodynamics, flight mechanics, large-scale optimisation and machine learning algorithms can be used to design better flight-planning routines and fuel prediction models. The partnership is now looking at building on the research outcomes, as well as focussing on new research areas such as weather avoidance.

#### Rio Tinto Centre for Mine Automation

The Faculty of Engineering has a successful long-standing partnership with Rio Tinto to develop and deploy a range of AI related technologies to deliver a fully remote autonomous mining process. The research partnership's next phase will focus on providing improvements through automation in the safety, predictability, precision and efficiency of typical surface mining operations.

#### Defence Science Partnerships program with Defence Science and Technology Organisation (DSTO)

Researchers work with the Department of Defence and national

security agencies on collaborative research projects in key areas including material science, electronic warfare, human sciences such as nutrition and psychology, and autonomous systems.

#### Cooperative Research Centre to transform Clinical Neuroimaging with Al

The university's Brain and Mind Centre is using AI to improve diagnostic neuroimaging of brain ailments such as multiple sclerosis and dementia by developing novel, automated algorithms to be deployed on an AI platform that integrates with routine clinical radiology workflows. It will dramatically improve productivity, enhance reporting accuracy and rapidly identify critical imaging abnormalities.

#### Cooperative Research Centre for Smart Satellite Technologies and Analytics

The university is a key member in one of Australia's most significant space industry research concentrations, as part of a new Cooperative Research Centre for Smart Satellite Technologies and Analytics. The university brings



together a multidisciplinary team whose combined expertise spans 5G communications, IoT technology, embedded systems, small satellites and AI.

#### Key personnel

Professor Dacheng Tao – Professor of Computer Science ARC Laureate Fellow, School of Computer Science

Professor Dong Xu – Chair in Computer Engineering IEEE Fellow, School of Electrical and Information Engineering

Professor Eduardo Nebot – Patrick Chair in Automation and Logistics and Director, Australian Centre for Field Robotics

School of Aerospace, Mechanical and Mechatronic Engineering

Professor Salah SukkariehProfessor of Robotics andIntelligent Systems

School of Aerospace, Mechanical and Mechatronic Engineering

Professor Fabio Ramos – Professor of Robotics and Machine Learning and Co-director for the Centre for Translational Data Science School of Computer Science Professor Stefan Williams – Head of School School of Aerospace, Mechanical and Mechatronic Engineering

Professor Branka Vuceti – Director of the Telecommunications Laboratory ARC Laureate Fellow, School of Electrical and Information Engineering

Associate Professor Joseph Lizier – Associate Professor in Complex Systems ARC DECRA Fellow, School of Civil Engineering

Associate Professor Jinman Kim – Director of the BMIT Visual TeleHealth Lab School of Computer Science

Dr Lamiae Azizi – Senior Lecturer and Deputy Champion (Nano Grand challenge) The University of Sydney Nano Institute

Dr Dries Verstratae – Senior Lecturer in Aerospace Design and Propulsion School of Aerospace, Mechanical and Mechatronic Engineering

# The University of Western Australia

#### The University of Western Australia contact point:

Ms Sue Robson Manager Industry Engagement, Engineering and Mathematical Sciences

T: +61 8 6488 7423

E: sue.robson@uwa.edu.au

Associate Professor Mark Reynolds

- T: +61 8 6488 1615
- E: mark.reynolds@uwa.edu.au



#### **Skills and capability**

From mobile data and cloud computing, to AI and advanced software development, UWA researchers enable others to tackle technological challenges and devise innovative solutions to transform the way we live.

#### **Research strengths**

#### **Computational Systems**

The Adaptive Systems Research Group researches and develops computational systems that are able to adapt to, or learn from, the data, knowledge or environment in which they are working. The Group seeks to develop computational systems that employ evolutionary, learning, optimisation and modelling techniques to solve or improve performance on complex problems. Current projects in Al include:

- computational intelligence techniques for optimisation, modelling and control
- applications of multi-objective evolutionary algorithms



- evolutionary optimisation and design
- hypervolume calculation for multi-objective optimisation
- trust and social network analysis

### Real-time optimisation, scheduling, control and logistics

UWA has expertise in real-time optimisation, scheduling, control

create new practical reasoning and computation tools.

### Improving prediction of asset health and failures

The Engineering System Health Laboratory focuses on improving prediction of asset health and failures so that maintenance work can be planned and disruption avoided. This ranges from sensor development to

UWA has expertise in real-time optimisation, scheduling, control and logistics, developing solutions that address vehicle routing, storage, labour and resource scheduling, maintenance, and responses to unforeseen events

and logistics, developing solutions that address vehicle routing, storage, labour and resource scheduling, maintenance, and responses to unforeseen events. In going beyond what current optimisation applications and technology can deliver, the research group extends theoretical understanding to apply novel combinations of automata, genetic algorithms, linear programming, model-checking and Markov decision processes to

diagnostics and prediction algorithms, and evaluation of statistical and machine learning prediction models.

#### **Big Data**

The Big Data Processing and Mining Group is developing new techniques and systems to make sense of big data. It develops new algorithms to extract knowledge from large volumes of data, employing domain-specific techniques to first identify features of interest and then mining to discover the underlying patterns and structure. Automating the discovery of parameters for pattern discovery and changes of context eliminates the need for expert analysis for each new application.

#### Complex systems and processes

In close collaboration, the Complex Data Modelling Group develops mathematical, statistical and computational methodology with a research focus on model building to understand complex systems and processes.

#### **Intelligent Information Processing**

The Centre for Intelligent Information Processing Systems is active in the areas of intelligent systems, artificial neural networks, biomedical engineering, control, digital signal processing, parallel and distributed computing, image processing, pattern recognition, software engineering, spoken language systems, and embedded systems.

#### Robotics and automation research

UWA has a long history of robotics and automation research that has spanned all types of autonomous mobile robots, including intelligent driving and walking robots, autonomous underwater vehicles, and unmanned aerial vehicles. This effort represents a nexus between artificial intelligence, computer vision, control robotics, signal and image processing robotics and automation. The aim is to develop new techniques that allow systems to sense and move within their own environment in either a fully self-directed or human-guided fashion.

#### Computer Vision and Machine/Deep Learning

The internationally recognised Computer Vision and Machine/Deep Learning Group deals with images from different modalities, including a focus on object and target detection, recognition, classification, tracking and subtle change detection. The group is recognised for its contribution in several areas including object segmentation and recognition for robot grasping, 2D and 3D biometrics, audio-visual speaker and speech recognition, robotic vision and control, advanced computer vision and deep learning for marine ecology, computer vision for biomechanics and deep learning theory.



#### Quantum Information, Simulation and Algorithm

The QUISA research group combines expertise in quantum physics, pure and applied mathematics, data processing, machine learning, computing temporal logic and algorithm, which provides the promise of solving certain problems of practical significance otherwise intractable. It explores applications in quantum simulation, data processing, financial risk analysis, machine learning and classification, taking advantage of intrinsic quantum correlations and quantum parallelism. In particular, it examines which parts of existing classical algorithms can be sped up in the quantum setting with deterministic queries.

Research Group are world leaders in precision measurement involving frequency, time and quantum systems.

#### **Protection of Rights**

The Technology and the Public Interest Research Group contributes world class expertise in privacy, intellectual property, internet governance, and the law and politics of data, automation, and artificial intelligence. The group promotes and protects rights for individuals and communities faced with the harmful consequences of new technologies; and provides a robust, pro-innovation environment for the stimulation of civic tech development in the public interest.

The internationally recognised Computer Vision and Machine/ Deep Learning Group deals with images from different modalities, including a focus on object and target detection, recognition, classification, tracking and subtle change detection

#### **Precision Measurement**

In support of next-generation computational technologies, the Frequency and Quantum Metrology

#### Task automation adaption

The human factors group looks at adapting task automation to maximise human-system integration and

#### The University of Western Australia



optimising the balance between task automation and human manual control.

#### **Biological motion**

UWA studies precise measurement and optimisation of biological motion: computer vision and deep learning meet biomechanics.

#### **Research infrastructure**

The Pawsey Supercomputing Centre operates multiple supercomputers, data-intensive machines and storage systems that use the most advanced technologies available. The power of supercomputing not only allows researchers to perform existing work faster, but also unlocks new research avenues that would have been impossible using traditional computing methods.

In addition to providing supercomputing power, the Centre provides data storage for the most demanding research projects and can maximise the potential of these vast data sets through de-bottlenecking and optimising research workflows.

At EZONE UWA – a collaborative space where students can test and



develop innovative solutions – an unparalleled student experience can be provided, building an innovative and collaborative culture based on a science, technology, engineering and mathematics (STEM) capability like no other in the country.

While the West Australian node of the Australian National Fabrication Facility (ANFF) at UWA provides state-of-the-art facilities and expertise in infrared (IR) technology and micro-electrical mechanical systems (MEMS) design and fabrication processes for industry and the broader research communities. These capabilities are in high demand and unique in Australia.

#### Collaborations

As an innovation leader, UWA understands the role that research institutes play in the economy of building and sustaining the economy and ensuring there is a pipeline that is required to ensure the very important job creation and economic diversification.

The Department of Computer Science and Software Engineering has joined

forces with several leading software and computing companies, as well as public sector groups, to connect UWA graduates to real-life careers. Some of these partners include IBM, WA Main Roads and Immersive Technologies.

#### **Key personnel**

Dr Du Huynh – Senior Lecturer, Faculty of Engineering and Mathematical Sciences, Computer Science and Software Engineering

E: du.huynh@uwa.edu.au

Machine learning, data mining, video image analysis, computer vision, pattern recognition

#### Professor Mohamed Bennamoun – Computer Science and Software Engineering, Faculty of Engineering & Mathematical Science

E: mohammed.bennamoun@uwa.edu.au Machine Learning/Deep learning. 3D Biometrics, 3D reconstruction/recognition, Artificial Neural Networks/Deep Learning, Computer Vision, Control Theory, Forensic Image Processing, Pattern Recognition, Robotics, Signal/Image Processing, VR and immersive environments

#### Mr Chongchong Qi – Faculty of Engineering and Mathematical Sciences, School of Engineering

Hybrid Artificial Intelligence (AI) Approaches for Prediction Purposes

#### The University of Western Australia

#### Professor Ajmal Mian – Computer Science and Software Engineering, Faculty of Engineering & Mathematical Science

E: ajmal.mian@uwa.edu.au Sensor data fusion to achieve hyperspectral super-resolution in remote sensing

#### Professor Adrian Keating – Microelectronics Research Group, Faculty of Engineering and Mathematical Sciences

E: adrian.keating@uwa.edu.au Untethered sensing networks, Robotics, Sensors, Semiconductors

#### Associate Professor Rachel Cardell-Oliver – Head of Computer Science School

E: rachel.cardell-oliver@uwa.edu.au

Smart Sensing / Virtual Sensing – validate algorithms for minimizing the number of sensors and sensor readings needed to make reliable decisions, wireless sensor networks

#### Dr Jin Hong, Lecturer – Faculty of Engineering and Mathematical Sciences, Computer Science and Software Engineering

E: jin.hong@uwa.edu.au

Cyber Security, Network Security, Secure Software Development, Moving Target Defence

#### Professor Melinda Hodkiewicz – Faculty of Engineering and Mathematical Sciences, Mechanical Engineering

E: melinda.hodkiewicz@uwa.edu.au

Asset Management, Prognostics and Systems Health in Remote Operations, Asset Data Quality, Safety (Asset Management related)

#### Professor Arcady Dyskin – Winthrop Professor, Faculty of Engineering and Mathematical Sciences, Civil, Environmental and Mining Engineering

E: arcady.dyskin@uwa.edu.au Integration of digital technology, Real time Computational Monitoring

## Professor Mark Reynolds – Head of Physics, Mathematics and Computing

E: mark.reynolds@uwa.edu.au

Al, Machine Learning, Logic, Formal methods in Software Engineering and Optimisation, Automated Reasoning, Verification of systems.

#### Dr Tim French – Senior Lecturer, Faculty of Engineering and Mathematical Sciences, Computer Science and Software Engineering

#### E: tim.french@uwa.edu.au

Automated Reasoning, Logical Foundations of computer Science, Verification of systems, Real-time Scheduling and Dispatch (Mine), Simulation testbed for autonomous vehicles



Dr Lyndon (Ronald) While – Senior Lecturer, Faculty of Engineering and Mathematical Sciences, Computer Science and Software Engineering E: lyndon.while@uwa.edu.au AI, Evolutionary Algorithms, Scheduling,

Fast Algorithms

#### Professor Michael Small – Professor, Faculty of Engineering and Mathematical Sciences, Mathematics and Statistics

E: michael.small@uwa.edu.au

Modern Mathematics, Statistics and Data Science to drive improvements, Non-linear time series analysis and modelling, complex data modelling

#### Dr Wei Liu – Senior Lecturer, Faculty of Engineering and Mathematical Sciences, Computer Science and Software Engineering

E: wei.liu@uwa.edu.au

Self-learning bias regulations. Text mining, development of domain expertise, integration of communication robots, Network Performance Prediction, through data analytics

#### Professor Amitava Datta – Professor, Faculty of Engineering and Mathematical Sciences, Computer Science and Software Engineering

E: amitava.datta@uwa.edu.au

Network protocols, fast algorithm, wireless systems, routing protocols

#### Professor EJ Holden – Senior Principal Research Fellow, Faculty of Science, School of Earth Sciences

E: eun-jung.holden@uwa.edu.au

Advanced data analytics methods and tools to assist the extraction of geological information/knowledge from diverse types of data from regional scale spatial data to drill hole and other mine scale geodata

#### Dr David Glance – Senior Research Fellow, Faculty of Engineering and Mathematical Sciences, Computer Science and Software Engineering

E: david.glance@uwa.edu.au

AI, health informatics, public health and software engineering

#### Dr Julia Powles – Associate Professor, Faculty of Arts, Business, Law and Education, UWA Law School

E: julia.powles@uwa.edu.au

Governance and Regulation in tech space including Artificial Intelligence – Law Innovation and Tech Regulation & Governance

#### Dr Shayne Loft – Associate Professor, Faculty of Science, School of Psychological Science

E: shayne.loft@uwa.edu.au

Task automation design to maximise operator and system efficiency/safety



MEMBERS



















