Digital Science Initiative
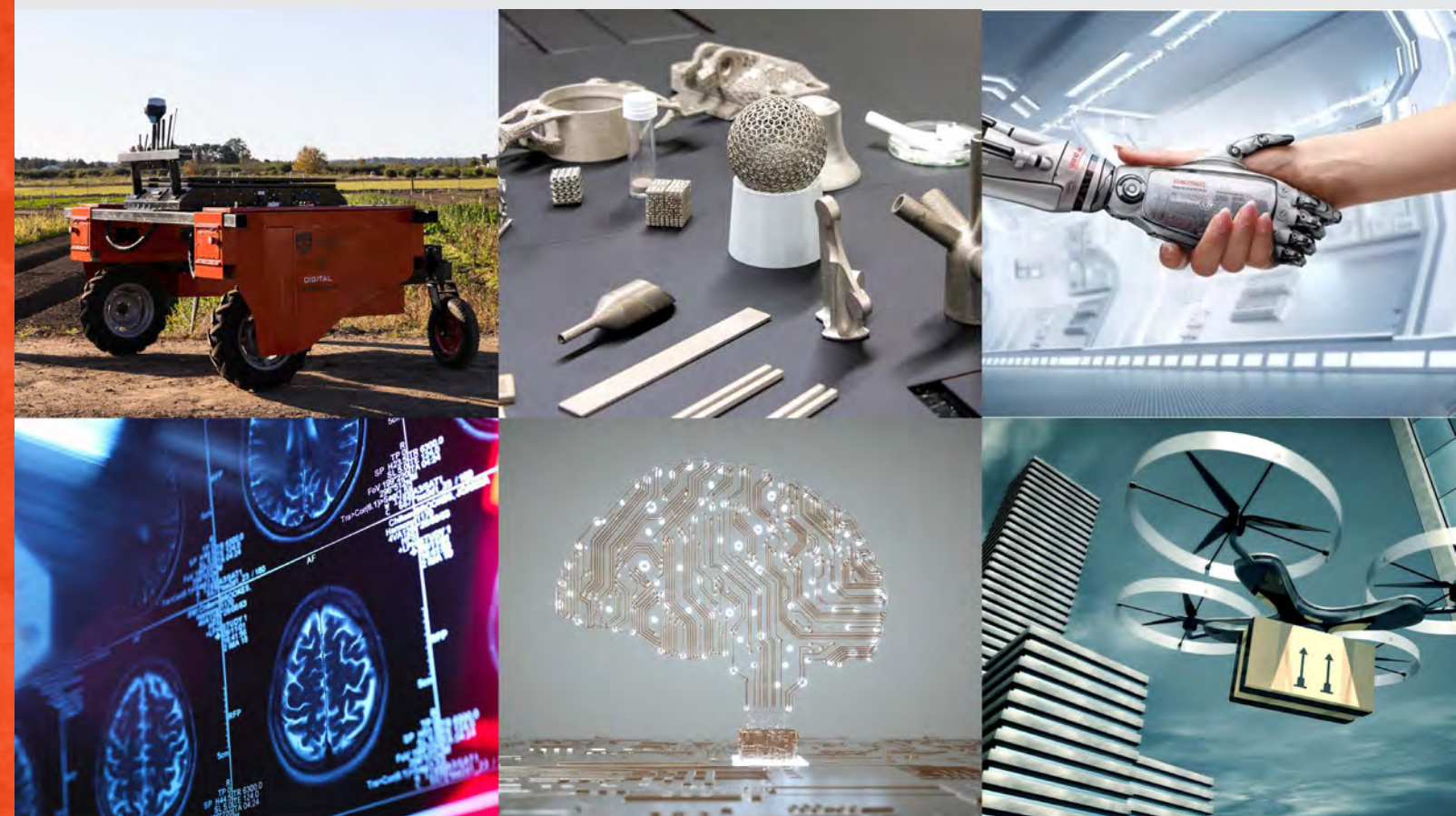*Annual Report 2023*

THE UNIVERSITY OF
SYDNEY

Digital Science Initiative
Annual Report 2023

We recognise and pay respect to the Elders and communities – past, present and emerging – of the lands that the University of Sydney's campuses stand on. For thousands of years they have shared and exchanged knowledges across innumerable generations for the benefit of all.

If you want to go fast, go alone. If you want to go far, go together.

African Proverb

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Director's Report

This has been another great year for the Digital Sciences Initiative (DSI). We undertook a comprehensive strategic planning process, refining our vision of establishing Sydney as one of the key international centres in digital innovation and articulating a new mission statement of 'Delivering Sovereign Capability in the Digital Sciences'. We have also refined our strategic priority activities, with a focus on fostering interdisciplinary research, working more closely with industry, growing our national and international partnerships, developing options for Masterclasses and short courses as well as programs for high school outreach, improving access to critical digital infrastructure and embracing a diverse range of contributors to the DSI objectives.

Across 2023, the DSI team has led a series of workshops to bring our academic colleagues from across the institution together to identify grand challenges of societal concern aligned with our research-oriented missions. This DSI cuts across faculties to address significant challenges in areas of health, agriculture and food, manufacturing, resources, energy and the environment, national security and social inequality. We have also engaged closely with industry to identify new areas for collaborative research, ranging from innovation in the aviation industry, new manufacturing technologies, the management of resources and energy, transformation of supply chains and logistics and innovation in the MedTech sector.

We are looking forward to another exciting year ahead with plans to continue growing our impact across the Digital Sciences. In 2024 we will focus on the theme of Digital Transformation, examining how recent trends in the digital sciences and technologies are reshaping industry sectors and society at large.

If you are interested in joining us, please reach out to dsi@sydney.edu. au to be included in future invitations for collaborative workshops and regular updates on our progress or subscribe to our email list.

We would like to thank **Professor Willy Zwaenepoel** for his visionary leadership and championship of academic research excellence through the Digital Sciences Initiative as he hands over the baton to **Hesham El-Gamal** in July 2024.

Professor Stefan Williams
Director, DSI

Foreword By Board Chair

It's a privilege to introduce the Digital Sciences Initiative (DSI) Annual Report for 2023. The DSI, since its inception, has been at the forefront of addressing the complex challenges and opportunities presented by digital technologies. Our vision—to position Sydney and, by extension, Australia, as a global leader in digital sciences—is more relevant today than ever.

This year's report highlights DSI's continued commitment to interdisciplinary research, fostering partnerships with industry, and nurturing the next generation of digital science leaders. DSI brings together the full capability of the University of Sydney to focus on industries critical for Australia's future - health, agriculture, defence, resources, energy and the environment.

A particularly important aspect of DSI's work this year has been the strategic planning process, refining the Institute's mission and vision. This process has allowed the Institute to sharpen its focus on the areas where it can make the most significant impact, such as AI/machine learning, agriculture, advanced manufacturing, robotics, quantum computing, digital health, clean energy and sustainability.

The achievements outlined in this report have been made possible by the dedication and expertise of over 100 people from across every faculty of the University of Sydney. As we look ahead, I have every confidence this team will continue to grow, expanding the capabilities of the University, nurturing new discoveries, growing businesses of the future and making Sydney one of the leading places for digital science in the world.

Dr Tim Fountaine
DSI Governance Board Chair

About the Digital Sciences Initiative

The University of Sydney's Digital Sciences Initiative (DSI) was launched in 2020 to help NSW and Australian industry, society and government seize the opportunity to be a global leader in the digital revolution. The main emphasis of our work is on addressing significant societal challenges in the digital space and achieving meaningful impact through research, education and external engagement. It follows a unifying future-focused strategy encompassing all disciplines across the faculty.

Our Vision

Our vision is for (the University of) Sydney to be recognised as a global leader in the Digital Sciences, with strong programs of research, education and engagement that lead NSW and Australian industry, society and government in seizing this generational opportunity for digital transformation.

Research   Education   Engagement

Our Mission

Delivering sovereign capability in digital sciences
The DSI aims to position the University of Sydney as a driving force for fundamental digital science and digital technology research by providing an ecosystem where researchers, industry, investors and policy makers can explore ideas, collaborate, and create; and to be a destination where a new generation of digital scientists, engineers, and entrepreneurs are mentored and trained. We are supporting research, training and engagement opportunities with a focus on excellence, scale and impact within our broad stakeholder communities and are on the lookout for new partners to join us in exploring this transformative area of research and development.

Our Research-Oriented Missions

Innovations in the digital sciences represent keystone technologies that will impact all facets of our lives. The DSI is designed to deliver research, education and training at an ambitious scale by creating opportunities for staff to work together across traditional faculty boundaries to address significant digital challenges of societal impact and concern. Our focus on sovereign capability is designed to encourage our researchers to consider the industrial, economic, logistical, research and educational capabilities required by the country to achieve objectives including safety, defence, health and wellbeing, food security, energy and key materials supply, infrastructure security, and environmental sustainability. This program is also designed to directly contribute to the University's strategic focus on excellence in research through tackling the greatest challenges that contribute to the common good.

Each of our research-oriented missions brings together a range of academics from Engineering and across the university to deliver focused research excellence and impact at scale. We are breaking down traditional School and Faculty based silos and encouraging research teams drawn from across the institution to tackle some of society's most pressing challenges. Our fundamental research programs are focused on four key areas of innovation that are transforming the digital landscape.

DIGITAL HEALTH	DIGITAL AGRICULTURE	DEFENCE	ADVANCED MANUFACTURING MATERIALS	ADDITIONAL MISSIONS
MODELLING, STATISTICAL INFERENCE, DIGITAL TWINS, SIMULATION, COMPLEX SYSTEMS, …	PRECISION AG, SOIL SENSING, LOGISTICS	NETWORKS, AUGMENTATION	ADDITIVE, DESIGN, OPTIMISATION	ENERGY AND ENVIRONMENT, DIGITAL TRANSFORMATION

ENABLERS

DATA-CENTRIC ENGINEERING
MODELLING, STATISTICAL INFERENCE, DIGITAL TWINS, SIMULATION, COMPLEX SYSTEMS, …

CYBER-PHYSICAL SYSTEMS
ROBOTICS, MACHINE LEARNING, COMMUNICATIONS, NETWORKING, …

DIGITAL HARDWARE
PHOTONICS, MEMS, FPGA, QUANTUM, SENSING, COMPUTING ARCHITECTURE, …

DIGITAL SOCIETY
ETHICS, LAW, ECONOMICS,SKILLS, EDUCATION, …

DSI Key Focus Areas

In order to promote collaboration and research in the digital sciences, the DSI is focused on the following strategic initiatives.

- Facilitating multidisciplinary collaboration and networking opportunities within the university
- Providing dedicated support for fostering new collaborative opportunities in research and engagement
- Transforming the digital educational offerings of the University

- Developing large centre proposals with partners from industry, government and not-for-profit organisations
- Bringing teams across the university together to address societal challenges
- Building digital Infrastructure
- Driving the establishment of a Digital Hub to catalyse digital transformation efforts
- Creating a vibrant research community with a focus on mentorship ECRs, HDRs and UGs across the university with interest in Digital Sciences Research and education.

Digital Sciences

The Digital Sciences Initiative takes an interdisciplinary approach that allows us to harness the collective expertise of academics from across our faculties, research centres, industry and government to drive innovation and address pressing societal challenges using digital sciences and technologies.

People

Governance Board

Professor Stefan Williams
Director

Industry Governance Board

Dr Tim Fountaine
Senior Partner, *McKinsey & Company* (Chair)

Dr Peter Bartlett
Principal Scientist,
Google Deep Mind

Michelle Bauman
Head of Data Science &
Analytics Transformation –
Woolworths Group

Chris Vonwiller
Co-Founder and former
Chairman of *Appen*, Chairman
of the *Warren Centre for
Advanced Engineering*

Dr Steven Farrugia
Chief Technology Officer,
Nanosonics Ltd

Governance Board - University of Sydney Representatives

Kirsten Andrews
Vice-Principal (External
Relations), PVC External
Engagement

**Professor
Benjamin Eggleton**
Pro-Vice-Chancellor
(Research)

Jeremy Hammond
Director, Strategic Ventures,
Strategy Portfolio

Management Committee

Professor Dan Corbett
Digital Defence Research

Professor Salah Sukkarieh
*Australian Centre for
Robotics*

Professor Jinman Kim
School of Computer Science

**Associate Professor
Daniel Gozman**
*University of Sydney
Business School*

Professor Kalervo Gulson
*Sydney School of Education
and Social Work*

Professor Philip Leong
*School of Electrical and
Computer Engineering*

**Professor
Gwenaelle Proust**
School of Civil Engineering

**Professor
Masahiro Takatsuka**
School of Computer Science

Professor Tim Shaw
School of Medical Sciences

Professor Kimberlee Weatherall
The University of Sydney Law School

Associate Professor Luping Zhou
School of Electrical and Computer Engineering

Professor Jennifer Whyte
School of Project Management and *Director of John Grill Institute for Project Leadership*

Professor Matthew Cleary
School of Aerospace, Mechanical and Mechatronic Engineering

Professor Ian Manchester
Director of *Australian Centre for Robotics*; and *Australian Robotic Inspection & Asset Management Hub* (ARIAM)

Sandra Margon
Head, External Relations, *Faculty of Engineering*

DSI Mission Leads

Professor Salah Sukkarieh
Digital Agriculture

Professor Matthew Cleary
Datacentric Engineering

Associate Professor Luping Zhou
Digital Health Imaging

Professor Dan Corbett
Digital Defence Research

Professor Philip Leong
School of Electrical and Computer Engineering

Professor Jinman Kim
Digital Health Imaging

Professor Gwenaelle Proust
Advanced Manufacturing and Materials

Professor Masahiro Takatsuka
Digital Education

DSI Staff

Dr Supriya Pillai
Operations Manager

Ms. Kelisha Lyndon
Business Development
Manager

Ms. Katie Yang
Business Development
Manager

Dr Peter Lok
Education Design

Executive Summary

The mission of the Digital Sciences Institute (DSI) is to deliver sovereign capability in the Digital Sciences.

Digital Sciences refer to the interdisciplinary field that encompasses the study of digital technologies, their impact on society, and the scientific principles underlying their development and application. The DSI aims to position the University of Sydney as a recognised global leader in the digital sciences, with strong programs of research, education and engagement supporting industry, society and government in seizing this generational opportunity for digital transformation. We will be the catalyst for the creation and transformation of digital industries; a driving force for digital science research that provides an ecosystem where researchers, industry, investors and policy makers can explore ideas, collaborate, and create; and a destination where a new generation of digital scientists, engineers, and entrepreneurs are mentored and trained.

Each of our research-oriented missions will bring together academics from across the university to deliver focused research excellence and impact at scale. We have over 100 researchers committed to support the DSI from across all Faculties of the University. We are encouraging research teams drawn from across the institution to tackle some of society's most pressing challenges. Key

DSI research priorities are focused on supporting the Critical Technologies in the National Interest, including in AI/machine learning, advanced manufacturing, robotics, quantum, biotechnologies and clean energy generation and storage. The DSI aims to catalyse advancements in these areas by strategically aligning research efforts in digital sciences and technologies to contribute significantly to the nation's technological landscape. The DSI will focus on three fundamental research areas (Data Centric Engineering, Cyber-Physical Systems and Digital Hardware), complemented by a fourth theme examining the societal and economic impacts of these developments (Digital Society). These fundamental research capabilities will underpin and support applied programs of research in Digital Health, Precision Agriculture, Advanced Manufacturing, Defence, Resources, Energy and Environmental stewardship. This will engage research expertise across the institution, to support long-term developments across the fields of digital innovation, mediated and informed by their societal context. We will also continue to engage with industry to ensure strong pathways for translation with our on-going programs of work and to look for new collaborative opportunities.

DSI 2023 Year in Review
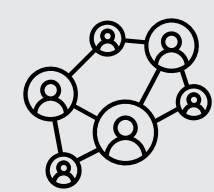
8
Research Pilot Projects

15
Stage 1 Seed Workshops

8
Distinguished Seminar Speakers

3
Stage 2 Scoping Studies

$900k
Funding Allocated

3
Stage 3 Large Scale Centre Bids

>$3M
Leveraged Funding

>50
DSI Retreat Participants

9
Vacation Research Scholarships

>50
Industry visits

DSI Mission Updates

Digital Agriculture
Mission Lead – Professor Salah Sukkarieh

Mission Strengths

Our research group integrates expertise from engineering, agriculture, social sciences, economics, and the physical sciences, offering a comprehensive perspective on digital agriculture. We focus on both technological innovations and the socio-economic and biophysical factors affecting agriculture. Through collaboration, we develop practical, sustainable solutions tailored for farms of all sizes. Our multidisciplinary approach, combined with strong industry partnerships, ensures our research is directly applicable and beneficial to the agricultural sector.

Mission Objectives

Our mission objectives are precisely aligned with addressing key global challenges through digital agriculture:

- **Food Security and Population Growth:** We aim to revolutionise agricultural practices by harnessing digital innovations, including robotics, the Internet of Things (IoT), edge computing, digital twinning, and artificial intelligence (AI). Our research is dedicated to boosting agricultural productivity, thereby ensuring a reliable food supply to meet the demands of a rapidly increasing global population.
- **Environmental Sustainability:** Our objective is to pioneer a future where digital technology equips farmers of every scale to not only boost productivity but also to protect our natural environment. This involves the strategic application of precision agriculture techniques to enable precise application of water, fertilizers, and pesticides, thereby reducing waste and environmental degradation. By integrating data analytics and AI, we facilitate smarter decision-making that aligns with sustainable farming practices, effectively reducing the carbon footprint and ensuring the judicious use of resources **to safeguard them for future generations.**
- **Economic Disparities among Farmers:** We are committed to bridging the technological divide, narrowing the gap between large-scale commercial operations and small-scale subsistence farming. Through the democratisation of technology, our goal is to equip farmers, irrespective of their scale, with digital tools and insights. This approach aims to equalise opportunities, enabling small-scale farmers to enhance their yields and improve their financial positions, thereby addressing economic disparities within the agricultural sector.

Mission activities for 2023

- Over the past year, our mission activities have been characterised by a robust schedule of fortnightly meetings and a series of internal workshops, designed to foster collaboration and innovation within our multidisciplinary team. These gatherings have united experts from Engineering, Computer Science, Agriculture, and the Sciences, facilitating a rich exchange of knowledge and research findings.
- Key stakeholders involved in these activities include academic researchers from the University's Departments of Engineering and Computer Science, alongside specialists in Agriculture and Environmental Sciences. Industry partners have also played a crucial role, contributing real-world insights and challenges that our research aims to address. These interactions have not only enhanced our team's cohesion but have also sharpened our focus on developing digital agriculture solutions that promote environmental sustainability.
- Through these collaborative efforts, we have made significant strides in integrating advanced technologies such as IoT, edge computing, and AI with agricultural practices. Our aim has been to create scalable solutions that improve productivity while reducing the environmental footprint of farming. The workshops and meetings have been instrumental in aligning our research objectives with the needs of both the agricultural sector and the environment, laying a solid foundation for attracting funding and support for our mission.

Mission Outcomes in 2023

2023 was a foundational year for us, marked by successful team building, securing of essential funding, international exposure, and the initiation of research and development projects aimed at transforming digital agriculture. Our efforts have set a solid base for future advancements and contributions to the field.

- **Effective Internal Collaboration:** We successfully brought together a diverse team of experts from Physics, Agriculture, Science, and Engineering. Through internal meetings and workshops, we identified and defined our collective strengths, fostering a multidisciplinary approach to tackle the challenges in digital agriculture.
- **External Engagement for Funding:** Our engagement efforts beyond the university bore fruit as we secured philanthropic funding. This crucial financial support kickstarted two pivotal projects: the development of digital and automated systems for sustainable animal foraging, and the deployment of advanced sensor networks for comprehensive monitoring of water and soil macro-nutrients using a combination of stationary sensors, robots, and drones.
- **International Showcase and Contributions:** A highlight of our year was showcasing our innovative robotic solutions at a conference in Europe, drawing international attention to our work. Furthermore, our Mission Lead contributed to the United Nations Food and Agriculture Organization (UN FAO), focusing on smart mechanisation for small-holder farmers. This participation underscored our commitment to making a global impact.
- **Research and Development Activities:** Our team, including newly hired postdoctoral researchers, PhD candidates, and technical staff, embarked on preliminary field trials. These trials were instrumental in testing our theories and prototypes in real-world conditions, providing invaluable data to refine our approaches and technologies.
- **Stakeholder Engagement:** Key stakeholders in our activities included academic peers from various disciplines within our university, philanthropic organisations that provided funding, and international bodies like the UN FAO. Collaboration with these stakeholders not only provided the financial and intellectual support needed but also offered platforms for showcasing our research to a global audience.

Funding opportunities leveraged/ planned

- In 2023, our newly established research group made significant strides in securing the foundational elements necessary for impactful research in digital agriculture. A pivotal achievement was our success in external engagement, which led to securing philanthropic funding. This funding was instrumental in kickstarting two key projects: the development of digital and automated sustainable animal foraging systems, and the deployment of advanced sensor networks for comprehensive monitoring of water and soil macro-nutrients. These projects are not only at the heart of our mission to enhance agricultural productivity and sustainability but also serve as a testament to our capability to attract significant support for innovative research.
- Building on these foundational projects, our team is actively exploring avenues for research translation and commercialisation from these projects. The sensor networks and automated foraging systems represent breakthrough technologies with the potential to revolutionise farming practices. By engaging with industry partners and leveraging the expertise of our technology staff, we are undertaking preliminary field trials to validate these technologies in real-world agricultural settings. These efforts are aimed at demonstrating the practical value and scalability of our innovations, setting the stage for commercial partnerships that can bring these solutions to market.
- Furthermore, our group is committed to obtaining further funding to advance smart mechanisation specifically designed for the cultivation and processing of indigenous grains. Acknowledging the critical role these crops play in global food security and their contribution to sustainable agricultural practices, we are crafting proposals that underscore the advantages of smart mechanisation. These include increased yields, reduced labour requirements, and improved production quality of native grains, while preserving cultural heritage. Our objective is to appeal to both governmental and non-governmental organisations that support agricultural innovation and sustainability, by demonstrating the multifaceted benefits of integrating smart mechanisation into the cultivation of indigenous grains.
- Lastly, our commitment includes a strong focus on smart mechanisation for developing countries. Our participation in international forums, such as the

conference in Europe and contributions to the United Nations Food and Agriculture Organization (UN FAO), underscores our mission's global perspective. By showcasing our work on innovative robots and smart mechanisation solutions, we aim to attract funding and partnerships that will enable us to tailor these technologies for small-holder farmers in developing countries. This approach not only aligns with our objectives of enhancing food security and economic resilience but also demonstrates our dedication to making a meaningful impact on a global scale.

Planned activities for 2024

In 2024, our group is poised to undertake a series of strategic activities designed to amplify our impact, extend our reach, and further our mission's objectives. These activities are planned to ensure that our research not only advances scientific knowledge but also translates into tangible benefits for the agricultural sector and beyond.

We plan to strategically publish our research findings in a manner that ensures maximum visibility and accessibility. By targeting high-impact journals and engaging with open-access platforms, we aim to reach a broad spectrum of stakeholders, from academic peers to industry practitioners, thereby fostering a wider dissemination and application of our work.

Enhancing our media presence is another key objective for the coming year. Through regular updates, engaging content, and active participation in social media discussions, we intend to build a stronger connection with our audience. This approach will help us to highlight the significance of our research, attract potential collaborators, and increase public awareness of the challenges and solutions in digital agriculture.

A major focus will be on consolidating and solidifying the outputs of our ongoing projects. By critically evaluating our progress and outcomes, we aim to maximise their impact and ensure they are closely aligned with our mission's core objectives. This involves refining our methodologies, extending our research findings, and exploring new avenues for innovation within the scope of our work.

Lastly, securing further funding remains a pivotal aspect of our strategy for 2024. This will not only support the continuation and expansion of our research activities but also facilitate the translation of our findings into practical applications and commercial opportunities. By demonstrating the value and potential impact of our work, we aim to attract investment from a variety of sources, ensuring the sustainability and growth of our research initiatives.

DSI Supported *members/activities*

- The Digital Science Initiative (DSI) has played a pivotal role in supporting our research group's activities and appointments, significantly contributing to our mission's advancement.
- The robot demonstration at the Field Day at Narrabri Plant Breeding Institute showcased our cutting-edge agricultural technology, made possible through DSI funding. This event not only highlighted the practical applications of our research but also facilitated engagement with the agricultural community, fostering discussions on future collaborations.
- Our participation in a prestigious conference in Europe, coupled with the transportation and demonstration of our small-holder robot, The Digital Farmhand, to the UNFAO headquarters, was partially funded by the DSI. This dual engagement allowed us to present our latest research findings and demonstrate our technology directly to an international audience, including the Director General. The DSI's support was crucial in facilitating these opportunities, enabling us to showcase the global applicability of our research and to foster international collaborations and recognition.
- The hiring of a program manager, a position partially funded by the DSI, has significantly bolstered our research group's operational efficiency and project management capabilities. This role has been central to coordinating our diverse activities, streamlining processes, and ensuring the alignment of our projects with our strategic objectives. The DSI's support in this appointment has been vital in enhancing our group's capacity to deliver on our ambitious research agenda.

Digital Defence
Mission Lead –
Professor Dan Corbett

Mission Strengths

We bring advanced innovation and research to defence problems in autonomy, communications, energy, hypersonic design, electronic warfare, and information warfare. We apply next generation techniques and thinking to future problems of resilience and security. Our leading research capabilities include:

- Computing and Sensors
- Networks, Communications, Cyber
- Information Warfare and Electronic Warfare
- Robotics and Machine Learning
- Computational Design and Engineering
- Materials Design and Modelling
- Advanced Manufacturing
- Medical Devices and Technology
- Human Performance
- Cognition and Decision Support
- International Security
- Quantum Technologies

We have a proven track record of partnering with industry & government on defence projects, including tenders/contracts & research funding options.

Mission Objectives

To translate excellence in research and training into strategic defence advantage for Australia and its allies. Our mission is to leverage our expertise and capabilities to support the Australian Defence Force (ADF) in achieving its strategic priorities outlined in the National Defence Strategy and AUKUS while advancing national security and defence interests. We strive to bring forth advanced innovation and research to address defence challenges encompassing autonomy, situational awareness, communications, advanced manufacturing and materials, data-centric engineering, energy, hypersonic design, information warfare, optimisation of systems and supply chains, quantum technologies, and information warfare. We apply next generation techniques and thinking to future problems of resilience and security.

Through these efforts, we aim to play a pivotal role in safeguarding national security interests while supporting the ADF's strategic objectives and ensuring Australia's defence readiness in an evolving geopolitical landscape.

Defence Pillars

- **Agile Autonomous Systems** - To revolutionise the design-manufacture-operate engineering lifecycle and delivering integrated advancements in distributed additive manufacturing, AI for machine prognostics, miniaturised sensors and advanced data fusion, data-driven optimisation of operations, secure communications and human factors.

- **Cyber-Social Situational Awareness** - To deliver capabilities to identify, predict, and mitigate diffused security risks through a cross-disciplinary, multi-tiered approach within all information environments.

- **Human Integrated Sensor Systems** - To deliver real time, networked monitoring of key human biometric cues coupled with data fusion and analytics. Consolidates leading research in wearables and implantable sensors, data analytics and IoT.

- **Information Warfare and Misinformation** - To protect the integrity of information and decision-making processes against synthetic media, misinformation, cognitive stress, and disinformation, ensuring the resilience and effectiveness of defence operations in an era of evolving threats.

- **Decision support and cognitive modelling** - To provide comprehensive decision support tools that integrate advanced cognitive modelling techniques with AI/ML processes, enabling commanders to navigate complex operational environments with clarity and confidence. Leading to support for command decisions; data fusion, understanding human decision processes, applying human reasoning to AI/ML processes.

- **Quantum Technologies** - Harness the transformative potential of quantum-enabled technologies in precision sensing, computational prowess, and secure communications to secure a decisive advantage for Defence operations.

Mission activities for 2023

- Workshop 1 (April 2023): The team engaged with 40 key industry and government representatives from across the defence and space sectors to understand their training and future workforce needs and develop the centre objectives.

- Workshop 2 (August 2023): 92 people across industry, defence, government, and key peak bodies attended the second workshop that involved, three industry panel sessions and the plenary focused on issues critical to the establishment of a sovereign propulsion and launch industry to support strategic defence and space needs.

- Two Cognitive/AI Modelling Workshops were held in April 2023 with an exchange of presentations/discussions and lab visits at the University of Sydney and Defence Science Technology Group (DSTG) Platform division (Everleigh).

- A DSI Defence Strategy planning workshop was conducted in Oct 2023 to refine the groups focus and identify large scale opportunities across National Defence priorities.

- DSI provided support to the University's participation and engagement in the Indo Pacific Expo 2023. The DSI team collaborated across the University and in particular with research teams including: Sydney Nano Institute, Australian Centre for Robotics, and Sydney Manufacturing Hub, to ensure the event ran smoothly, showcased our research capabilities and experiences to more than 27,000 visitors, 832 companies across the three days. The DSI team supported industry connections during and post the event.

- >50 Industry visits co-ordinated across Government, Australian, US and UK Defence departments, key industry partners (Primes and SMEs), defence and space agencies/networks.

- >20 visits were organised with industry partners across Brisbane, Canberra, Sydney, Adelaide and Melbourne to enable DSI researchers to visit labs and facilities, meet with industry and understand key challenges .

Funding opportunities leveraged/ planned

- Awarded <u>Defence Innovation Network (DIN) Pilot Project</u> - *Edge AI in Multiple UAVs for ISR and Communications* is a multi-university and industry collaboration led by University of Sydney (CI: T J Lim and Thilakarathna). The project is investigating distributed machine learning algorithms for deployment in multi-UAV ISR and communication-centric applications that account for physical constraints such as payload, manoeuvrability and energy and minimize probability of detection.

Key Research Projects led by University of Sydney:

- A.Y. Zomaya, K. Thilakarathna, S. Seneviratne, A. Seneviratne. *Resilient and Secure Edge Computing for Untrusted Distributed Systems,* Australian Research Council-Office of National Intelligence (ARC-ONI Discovery Grant) for $568,514 (current).

- K. Thilakarathna, S. Seneviratne, A.Y. Zomaya, A. Seneviratne, S. Kanhere, Y.C., Lee, P. Ridley, *Resilient and Trustworthy Edge Computing,* Defence Innovation Network Strategic Investment Initiative, Defence Science and Technology Group, $496,162 (current).

Successful collaborations and partnerships

- DIN proposals – collaborations with Safran, L3 Harris, CruxML

- Small project – Merewyn Partners

Over the course of the year, we have facilitated collaboration with Associate Director, Defence Strategy and Engagement and workshops for more than 150 external stakeholders from various government agencies, including Defence services, the Defence Science and Technology Group (DSTG), as well as representatives from UK Defence, USA Defence, and NSW Invest. Additionally, participants from the defence industry, including both domestic and international Primes and SMEs, have been engaged.

These engagements have served as valuable opportunities to showcase our state-of-the-art research laboratories and facilities, allowing visitors to gain insights into our researchers' capabilities while fostering meaningful interactions and collaborations.

Publication Highlights

- Professor Zdenka Kuncic, from School of Physics with colleagues from UCLA, NIMS, Kyutech, and University of Sydney Nano Institute published a Nature Paper "*Online dynamical learning and sequence memory with neuromorphic nanowire networks*"

- Zdenka also published two articles through the conversation:

- <u>We built a 'brain' from tiny silver wires. It learns in real time, more efficiently than computer-based AI</u>

- <u>Networks of silver nanowires seem to learn and remember, much like our brains.</u>

Engagement and Impact

- AUKUS-oriented engagement with US organisations DARPA, ONR, ARL, University of Maryland, Johns Hopkins University
- Dan Corbett attended the Parliamentary Friends of Space briefing in Canberra, met and talked to MPs and staff
- Dan Corbett attended the Defence Space Capability Briefing in Canberra

Planned activities for 2024

- A national report to estimate the Defence workforce in the GWEO program will be published in April 2024. The report is titled *"Australia's Guided Weapons Enterprise: A Workforce Capacity Estimation Study"* wand authored by two of our highly talented Higher Degree by Research candidates Brendan Waters and Juan Rasines Mazo and Professor Matthew Cleary
- The team in March launched the "Australian Rocketry and Propulsion Training Network" https://dsi.sydney.edu.au/research/defence/arptn/ and those from the industry sectors of defence, space, education and government are invited to become a member if you are wanting to work together in shaping the future workforce in defence and space.
- DSI team will work with the Defence Central Leadership group, Sydney Manufacturing Hub and Core Research Facilities to plan the external event in partnership with Defence Innovation Network, for the upcoming Industry Forum titled "Industry Forum: Composite and Hybrid Structural Materials for Advanced Propellers" in June.
- Planned further opportunities to partner with Lockheed Martin Advanced Technologies Lab
- Planned future trips (mid-year) to Washington, D.C. for further engagement with US Defence agencies
- Approaching ONRG or AFOSR – Visiting Science Program (VSP): Apply for support for Kanchana Thilakarathna to visit Lockheed-Martin ATL in Cherry Hill, NJ
- The team will work with ONRG, AFOSR and US Defence Army to explore a topic of interest and explore hosting a Conference in 2025 funded through the "Collaborative Science Program (CSP)". This scheme supports international workshops and conferences of Naval, Terrestrial and Aerial interest.

- Provide support to Professor Matthew Cleary in establishing the "Australian Rocketry and Propulsion Network" and submit with UQ, RMIT and Monash University an ARC Industrial Training Centre in November 2024.
- Exploring projects across the Digital Sciences Institute and Sydney Manufacturing Hub
- Collaborating across the University to identify opportunities for researchers that align with large scale research programs to drive engagement and impact across Defence, Industry and Academia – for example:
- Australian Composites Manufacturing (AMC) CRC (formerly known as SoMAC CRC) is a $70m grant led by UNSW in partnership with 5 Australian Universities (USyd, Deakin, UWA, UQ and RMIT) and commenced operations in January 2023. The AMC CRC is a capable and creative consortium of industry, government, and research partners who will help the $100b international composites industry undergo a major automation transition. The node lead for "High Performance Composite Materials" is Professor Anna Paradowska. The DSI team are working collaboratively with Anna to identify key defence large scale projects and partners aligned to AMC.
- Sensing Technologies for Australian Resilience (STAR) CRC - (starcrc.com.au) will investigate the dual-purpose opportunities for Defence, National Security and Natural Hazard applications of smart sensing technology and data access to strengthen Australia's capability to address emerging threats and disasters in a changing environment. Bid submission March 2025, and the bid leader is Professor Sergio Leon-Saval. DSI will work closely with the bid team to see how our researchers and partners can become involved.

Digital Health Imaging
Mission Lead – Professor Jinman Kim and Associate Professor Luping Zhou

Mission Strengths

- Collective expertise in medical imaging, cutting across multiple modalities, and in AI/ML innovations. Three focus research areas: Imaging methods and infrastructure, Multi-modal learning, Explainable AI and workflow optimization.
- Combined with state-of-the-art imaging infrastructure including Australian Imaging Service (AIS) and National Imaging Facility
- Strategic partnerships with government and clinical entities including Local Health Districts, private hospitals, and medical institutions.
- Ability to pivot on large scale projects.
- Strong industry links.

Mission Objectives

Our objectives are to address societal challenges in the following research areas:

- **Health and Well-being:** Focusing on advancements in disease diagnosis, management, and personalized treatment. Improving equality of care. Addressing the need for affordable healthcare solutions
- **Workforce Adoption:** To enable AI Adoption in the imaging industry. Streamlining workflow processes and enhancing AI training practices.
- **Reduce inequality:** Ensuring accessibility and equality in advanced medical imaging services.
- **AI/Machine Learning Advancements:** To continue to innovate in the adoption of state-of-the-art ML/AI technologies to solve complex medical imaging challenges.
- **Explainable AI, Data Privacy, Safety, Validity and Logistic:** Enable AI Fairness and to add trust to algorithms. To develop AI systems with the properties of interpretability (how AI functions), explainability (how a decision is drawn), transparency, justifiability, and contestability, prioritizing privacy measures and data safety standards. Addressing Validity and Logistic concerns for medical imaging innovations.

Mission activities for 2023

1. Ran a workshop on MRFF opportunities to collaboratively brainstorm project proposal ideas, laying the groundwork for anticipated funding in 2024.
2. Successfully submitted an ARC ITTC proposal focusing on AI Medical Imaging Industry Transformation.
3. Progressed in multiple research projects initiated by the Mission, including BioHeart CT where we have recruited a postdoctoral fellow, and had two summer students developing software platform for data access.
4. Regular meetings to share knowledge and expertise, including members from both FE and FMH. These meetings lead to participation in member held workshops, grants, etc.
5. Grew the network of industry links and held multiple meetings, including 360 Med Care which has lead them to be a partner to the ARC ITTC proposal

Funding opportunities leveraged

- Secured a Philanthropic funding for a project led by Professor Gemma Figtree on BioHeart-CT to develop imaging algorithms to combine to multiple biological samples. There is a novel application of Image AI to extract biomarkers from CT coronary angiography (CTCA) and how to correlate these findings to Biological sample (mulit-omics / blood etc).
- Award of the MRFF Critical Research Infrastructure project AIS-SHIELDS (Securing Health Intelligence Efforts & Linking Data Silos), building on Australian Research Data Commons (ARDC) & National Imaging Facility invested Australian Imaging Service.

Planned activities for 2024

- To bid for a conference on AI Medical Imaging
- To organize a joint workshop with other missions (e.g. Defence)
- Continue to explore large scale funding opportunities.
- Continue to support our members in research and development across various projects.
- Explore opportunities to expand / integrate to Digital Health theme to extend our digital health imaging to broader health challenges. This will also enlarge our membership.
- Develop stronger links between Digital Health Imaging to other related centers at the University including Precision Data Science and CPC.

Education/training outputs

- Two summer internship students that worked on DSI related projects (one student for BioHeart CT and another on cross-modal learning)

Advanced Manufacturing and Materials
Mission Lead – Professor Gwenaelle Proust

Mission Strengths

Our capabilities span materials science and engineering, design and manufacturing, robotics, civil construction, and digital technologies like modelling and Artificial Intelligence, Machine Learning. Collaborations with Sydney Microscopy & Microanalysis, Sydney Analytical, Sydney Nano Institute, Australian Centre for Robotics, ARIAM Hub, and various labs across different schools and Core Research Facilities enhance our research outcomes. The Sydney Manufacturing Hub stands as a testament to our commitment to operational excellence and groundbreaking innovation. Our multi-disciplinary strategy explores Advanced Manufacturing Materials, encompassing optimisation of manufacturing processes, large-scale production automation with robotics, and innovations like 3D printing in biomedical applications for customised implants.

Mission Objectives

- Provide concept-to-production demonstration capabilities, including advanced pre- and post-processing of materials by using advanced manufacturing technologies and automation.
- Develop cost competitive and advanced manufacturing solutions by incorporating systems engineering, computer modelling and world class design in manufacturing workflow.
- Develop cutting-edge digital science and technology micro-credentials to enhance training and up-skill the existing workforce.

Key Research Themes

1. **Manufacturing Optimisation:** Process parameter development for new materials Development of new materials and standards Use in-situ measurement to increase manufacturing process reliability.
2. **Robotics Manufacturing:** Mass production line requires automation Cutting Edge Modelling and Robotics for complex manipulation and manufacturing. Large manufacturing areas that could benefit: Defence – for example naval ship building, and other industry sectors.
3. **Construction Durability:** Durability optimization Failure prediction through modelling Monitoring structure to avoid failure.
4. **Biomedical Applications:** Customised implants 3D printing of tissues and organs.

Mission Activities and Achievements in 2023

DSI Research Pilot Projects

From real-time anomaly detection in additive manufacturing to optimizing processing parameters for refractory alloy components, our group members were successful in securing 4 DSI pilot projects.

- Dr Xianghai An – Real-time anomaly detection in additive manufacturing processes using artificial intelligence.
- Professor Gwénaëlle Proust – Optimisation of processing parameters for the fabrication of refractory alloy components for space applications using laser powder bed fusion technology
- Dr Ali Hadigheh, Digitalising corrosion monitoring of structures by coupling new multi-functional optical sensing systems, machine learning techniques and digital twin models - included team members Professor Simon Fleming, Professor Marjoire Valix.
- Associate Professor Daniel Dias-da-Costa, Computer vision inspection of structures in post-disaster scenarios – included team members Prof Luming Shen, Dr Chang Xu, Mr. Elyas Asadi.

Grant success

- ARC Industrial Transformation Research Program, Training Hub on Future Digital Manufacturing (2024-2028). This Hub aims to grow and accelerate Australian digital manufacturing (DM) transformation by devising novel DM technology and commercialisation/adoption pathways. The hub is led by Swinburne University, with the University of Sydney leading the node on developing Machine Learning and Edge AI solutions for digital manufacturing. Professor Albert Zomaya, Dr Kanchana Thilakarathna and others, $12m ($5m from the government and $7m from industry).
- AMC (SoMAC) CRC: As previously mentioned in the DSI Defence Mission, the CRC commenced operations in January 2023 and Professor Anna Paradowska has successfully launched 3 projects with industry partners aligned to the node she is leading. One of the projects explores Composite Products Lifecycle 4.0, quality, health monitoring, manufacturing, reuse, and recycling, and is engaging multiple stakeholders.

- ARC LIEF Professor Gwenaelle Proust, $546,254.00 – improving access to powder manufacturing.
- ARC Discovery Project Professor Chun Wang; Dr Shuying Wu; Professor Jang Kyo Kim, $573,137 "Orthogonal Sensing Strategies for Soft Sensors to Discern Multiple Stimuli" awarded 2023. The project expects to generate new knowledge of orthogonal sensing mechanisms and the effects of microstructure designs.

Industry Engagement

We actively participated in over 50 industry visits across diverse sectors, including Defence & Security, Biomedical, Health, Transport, and Aerospace.

Partnerships

Collaborating with HERA on initial projects for the team to explore further topics of interests.

Recognition and Achievements

- Our mission lead Professor Gwenaelle Proust has been appointed Vice President of Materials Australia in 2024.
- Professor Gwenaelle Proust also co-chaired the successful 3rd Asia-Pacific International Conference on Additive Manufacturing (APICAM), attracting global attention.
- Professor Simon Ringer was awarded the Materials Australia Silver Medal for outstanding contributions to metallurgy.
- Ali Hadigheh's <u>research</u> featured in a range of media, highlighting our impactful research and innovations in
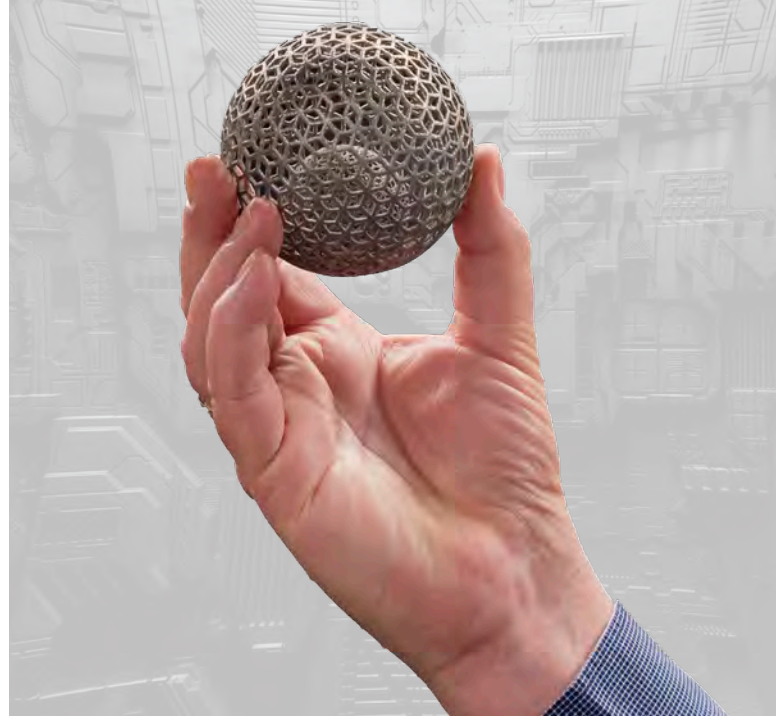
designing cheaper carbon fibre recycling to cut wind turbine waste.

Activities Planned for 2024

- Enhanced Collaboration: More extensive collaborations in computer science, engineering, bio-medicine, science, and other related disciplines.
- Bio-Med Initiatives: Initiatives in health, bio-medicine, and manufacturing to commence.

Funding Leverage: Applied for ARC Discovery Project and ongoing pilot grants, ensuring sustained growth and impact.

Data Centric Engineering
Mission Lead – Professor Matthew Cleary

Mission Objectives

Build Digital Twins of real-world systems that are capable of simulation, design, uncertainty prediction, and real-time control across the following domains:

- National Security: Develop data-centric models for autonomous warfare and natural disasters.
- Energy/Decarbonization/Electrification: Utilise data-centric models for decision-making for reliability, dispatchability, optimisation, (public) transport, recycling.
- Logistics: Create models for coordinating remote area health, food, and water production/supply, waste recycling, etc.
- Trust: Address technical solutions for privacy, combating bias, cybersecurity, data-centric model robustness, model interpretability, awareness, and education.

Mission Activities for 2023

Projects directly related to DCE group:

- Rio Tinto Aluminium: Stochastic models for Alumina quality management - Itai Einav, $1,059,360 over 3 years (PhD + postdoc).
- Collaboration with DARE ITTC: Data-Aided Stochastic Modelling of Cloud Brightening Plumes - Matthew Cleary, PhD project + industry internship.
- Systems Integration for Autonomous Block Cave Mining: Itai Einav, MPhil project (Jared Millane, Lead – Automation Delivery at BHP).
- Guwara Urban Wind and Plume Transport Models: Ben Thornber / Ian Manchester, DMTC, ~$800,000 over 3.5 years.
- Digital Engineering for Device-on-Demand: Dries Verstraete, Data61 Next Generation Graduates Program Round 1. PhD cohort program (DSI-Defence and DSI-DCE).
- Aerosol Plume Source Estimation: Matthew Cleary, Nick Lawson, and Matt Dunn, collaboration with DSTG, ANSTO, DefendTex.
- DSI Seed Funding 2023, supported 2 HDRs/RAs to work with Matt Cleary to produce workforce estimate report to be published by Q2, 2024.
- Honours Thesis and Project funding for HDR Student, 2 Vacation Research Internships Winter 2024 Scholarships and Equipment bought to support Aerosol project, Nick Lawson, Matt Dunn, Matthew Cleary.

Related Projects held by Group Members

- Professor Itai Einav: Developing a novel granular stress sensor for soil exploration - $413,390.
- Associate Professor Agisilaos Kourmatzis: Developing a high-resolution laser-based sensing system for inhaler flow computational model validation–$1.08m
- Projects in Preparation: ITTC for Propulsion Technologies and Launch Capabilities.
- <u>2023 SOAR Prize Winner:</u> Dr Qiang Tang is a Senior Lecturer at the School of Computer Science. His research interests lie in applied and theoretical cryptography, blockchain technology and privacy and computer security.

Collaboration Highlights and Recognition

- Long-Term Partnership with Rio Tinto Aluminium: PhD student and Post Doc funded through partnership. Regular meetings, workshops, and a site visit to the refineries in Gladstone in September 2023.
- Guwara DSTG Collaboration: Ongoing collaboration since 2021.
- Awards: Sydney Knowledge Hub PERIScope commercialization award to Associate Professor Kourmatzis for new technology for advanced sensing of particle deposition and dissolution behaviour. University spin-out being formed.

Media Engagement

- <u>Podcast</u> on data privacy by Dr Clement Canonne.

Seminars and Workshop Highlights

- Clement Canonne involved in co-designing the DSI Seminars launched in 2023

Members and/or activities for DCE supported through DSI

- DSI Seed Funding 2023, supported 2 HDRs/RAs to work with Matt Cleary to produce workforce estimate report to be published by Q2, 2024.
- Honours Thesis and Project funding for HDR Student, 2 Vacation Research Internships Winter 2024 Scholarships and Equipment bought to support Aerosol project, Nick Lawson, Matt Dunn, Matthew Cleary
- Funding received from DSI for the 6-month appointment of Post Doctoral Fellow, Matthew Macaulay in 2022, leveraged into funding of Rio Tinto Project in 2023

Highlighted Publications

- Clément L. Canonne, Samuel B. Hopkins, Jerry Li, Allen Liu, Shyam Narayanan: *The Full Landscape of Robust Mean Testing: Sharp Separations between Oblivious and Adaptive Contamination*. FOCS 2023: 2159–2168
- Shai Ben-David, Alex Bie, Clément L. Canonne, Gautam Kamath, Vikrant Singhal: *Private Distribution Learning with Public Data: The View from Sample Compression*. NeurIPS 2023
- Jayadev Acharya, Clément L. Canonne, Ziteng Sun, Himanshu Tyagi: *Unified Lower Bounds for Interactive High-dimensional Estimation under Information Constraints*. NeurIPS 2023.

Planned Activities for 2024

- Strengthening integration with other missions, Digital Agriculture, Advanced Manufacturing, and Materials.
- ITTC for Propulsion Technologies and Launch Capabilities.
- Building on work undertaken towards the end of 2023 to build scale and capability across the university of linking experts, research centres, labs and facilities together to work collaboratively on data-centric engineering projectsIdentifying large scale funding programs to work with researchers, the community, industry and government partners in collectively solving the complex problems posed by data.

Digital Hardware
Mission Lead – Professor Philip Leong

Mission Strengths

The team excels in addressing systems-level challenges through the members' expertise in the areas of quantum engineering, renewable energy, photonics, nanotechnology, computer engineering, machine learning, health, and well-being. With a focus on translational opportunities, the mission aims to commercialise products and tackle societal challenges in resources, energy, environment, health, cybersecurity, climate change, and defence.

Our vision is to contribute to society through advancing knowledge in computer hardware, sensors, and actuators.

Mission Objectives

- Apply our unique combination of hardware, control, signal-processing and machine learning expertise that can be used to address systems level problems over a wide range of fields.
- Propel research in integrated circuits, quantum, MEMS, and computer hardware design with a focus on system-level design.
- Create teaching programs to shape the next generation of engineers and upskill existing graduates.
- Build a team of experts to assist industry and academia in developing bespoke analogue and digital devices, fostering the translation of research to industry.

Our core expertise

- Autonomous underwater vehicles; navigation, planning and control.
- Fusion of radar, radio and sonar data
- Ultrasound and quantum magnetic field sensors
- Anomaly detection
- Acoustic, Photonic and Cyclostationary signal processing
- Bespoke FPGA acceleration and custom hardware design
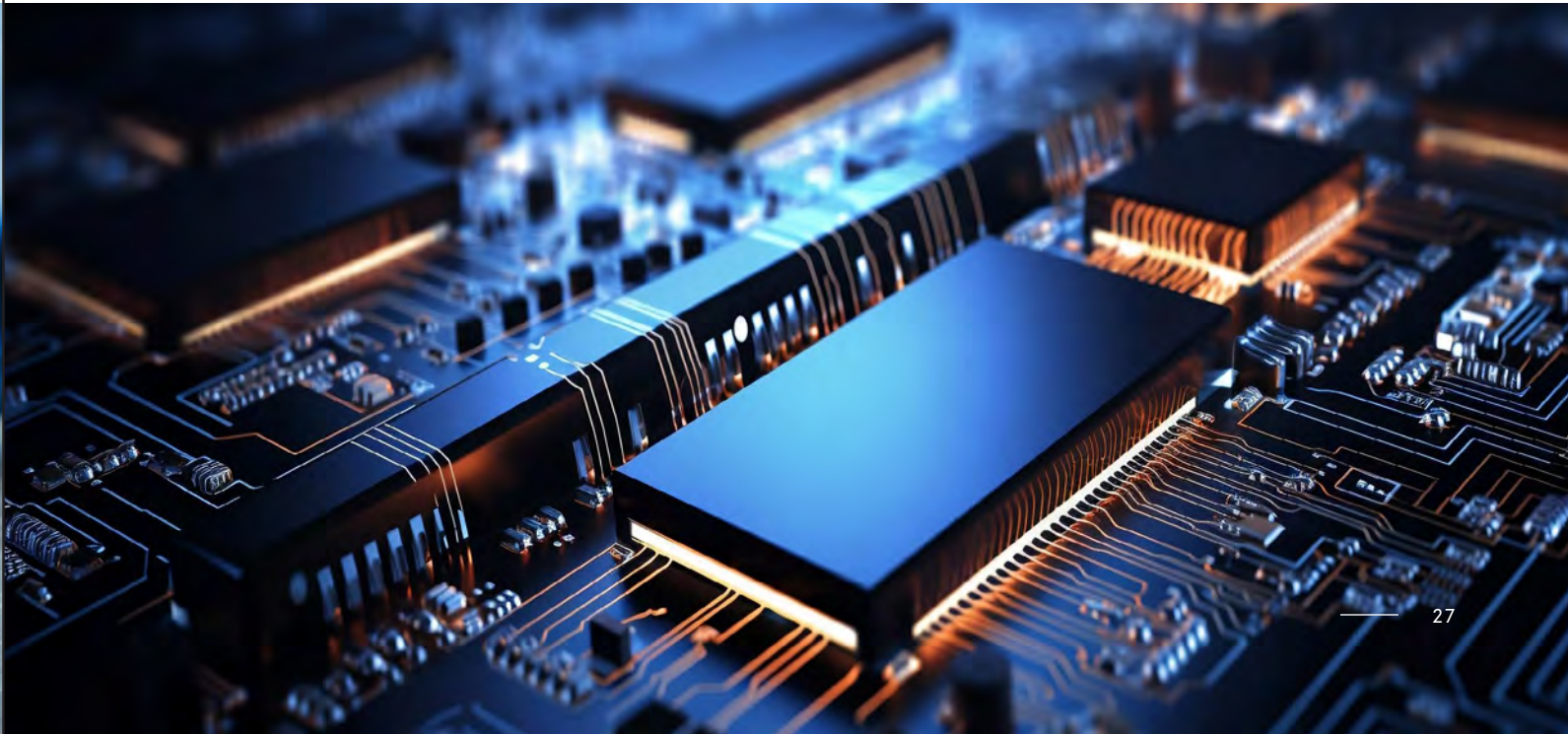- Micro/Nanofabrication

Our capabilities and Infrastructure

Capabilities

- Integrated circuits, signal processing and FPGAs
- Photonics
- MEMS
- Underwater systems
- Robotics
- Quantum
- Space

Infrastructure

- Sydney Nanoscience Hub
- ACFR
- Sydney Manufacturing Hub / Prototype Foundry

Key Achievements 2023

- Formed the Digital Hardware group in July 2023 with several productive working party meetings.
- Professor Sri Parameswaran was among 8 Australians to receive <u>IEEE Fellowship in 2023</u>. This distinguished achievement is a testament to excellence in research and global impact. Professor Parameswaran is a world-renowned expert in computer engineering, recognised for his development of fast, cost-effective programmable hardware systems used for cybersecurity, image processing, AI and DNA analysis.
- Collaborated with industry partners to explore future research projects such as Merewyn Partners, Safran, and L3Harris.
- Successfully participated in international conferences, including Indo Pac 2023, DSEI in London, and US trips involving DARPA I2O, INS-MIT, and MTO.
- Submitted a proposal to DIN SRII NSW.
- Pursued funding opportunities in defence and national security, including AUKUS, ASCA, DIN, and US DoD.
- <u>2023 SOAR PRIZE Winner:</u> Niels Quack is an Associate Professor in the School of Aerospace, Mechanical and Mechatronic Engineering and a member of Sydney Nano. His research focuses on micro- and nanosystems engineering, with an emphasis on exploring micro- and nanofabrication techniques, materials, and integration of mechanics and photonics at the micro- and nanoscale. These novel micro- and nanosystems find applications in fiber-optical communication systems, imaging, quantum sensing, computing and information processing, sensors and space communications.

Research Highlights

- Substantial engagement in events like October Sky and Indo Pac 2023, being part of the University's booths and showcasing the University and DSI research capabilities and infrastructure to Australian and international industry and defence delegates.

Publication Highlights

- Professor Ben Eggleton published a conversation article titled "<u>Photonic chip that 'fits together like Lego' opens door to local industry</u>"
- Associate Professor Niels Quack published with colleagues from EPFL, CSEM, KTH, 3DSIP, TNI, and Ghent University a Nature Paper titled "Integrated silicon photonic MEMS"

Collaborations

- Established collaborations across the university including MDIs, Sydney Quantum Academy and Net-Zero Initiative

Media and Outreach

- Active participation in workshops and conferences, planning for the 2024 ICFPT conference.
- Engaged in media and outreach activities across the team, some highlights include:.
  - <u>Teams develops silicon photonic MEMS compatible with semiconductor manufacturing</u>
  - <u>Photonic chip that 'fits together like Lego' opens door to local industry</u>

Planned Activities for 2024

- Themes identified through the Digital Hardware Strategy sessions in 2023 highlighted:
  - Communications and Sensing
  - Integrated Circuits and MEMs
  - Clean Energy and the Environment
- With members and partners will decide on areas of focus to maximise the expertise across the group and take advantage of the unique infrastructure, labs and facilities to support research projects.
- Exploring potential funding from the NSW Digital Restart Fund and CRC-P program with key industry partners.

Digital Society
Mission Lead –
Professor Kalervo Gulson

Mission Strengths

Our mission thrives on the unique opportunities presented by contemporary societal challenges at the intersection of AI and society. The introduction of ChatGPT underscores the intricate sociotechnical nature of AI, addressing issues of trust, environmental impact, and shifts in expertise. The profound influence of AI on public domains like health and education demands interdisciplinary collaboration, bridging the realms of Humanities, Arts, Social Sciences (HASS), and STEM disciplines. Recognizing the lag between technological innovation and policy evolution, our initiative stands out as one of the few in Australia seamlessly integrating social and technical expertise. Our team, spanning the Faculties of Engineering, Arts, Social Sciences, Business, and Law, collaborates extensively with key players in the field, fostering diversity and comprehensive insights for impactful research.

Mission Objectives

Inaugural Workshop (October 2023): The mission conducted a workshop, laying the foundation for collaborative.

- Societal Impacts of AI: Delve into the far-reaching consequences of AI, exploring its effects on various aspects of society such as health, education, and public provisions.
- Policy/Governance and Technology:
- Expertise Gap between Social and Technical Approaches to Emerging Digital Technologies, etc

Mission activities for 2023

Inaugural Workshop (October 2023): The mission conducted a workshop, laying the foundation for collaborative efforts.

Retreat Workshop Outcomes: During a retreat workshop, the mission identified and prioritized five research themes:

- Human machine interactions: Focus on the new types of interactions and collaborations emerge when AI is used in education, and issues of transparency, explainability, etc
- Logistics and supply chain: Climate and environmental factors in the use of AI in education, infrastructure issues

- Digital Policy and governance: The ways in which AI in education changes how governing happens.
- Participatory methodologies: There is a need for broad and diverse stakeholder involvement in decisions about both the development and use of AI personalisation technologies in education.
- Trust, accountabilities and governance: Issues in how we govern AI in education (knowledge, institutions, etc).

Mission Outcomes in 2023

As the first meeting of the mission was held in late 2023, the outcomes of the mission were only that the mission was established.

Funding opportunities leveraged

FASS has allocated two lots of funding for 2024: 1. In the digital inequalities area ($25K – led by Dr Teresa Swist); and 2. To explore the possibility of a ITTC on AI and Society ($45K).

Planned activities for 2024

- Seminar series - Issues in personalisation in education: 2 to 3 researchers through from different fields talk through a problem; Possible new research problems to emerge.
- Experiments in participatory methodologies: Design workshops on human-machine collaboration, building new tools through participatory approaches.
- Scoping workshops: New multidisciplinary research programs; New external funding opportunities
- Digital transformations in rural and remote communities. Led by Tim Shaw.
- Scoping workshops for a ITTC on AI & Society (either for Nov 2024, or Nov 2025).

Digital Education
Mission Lead –
Professor Masa Takatsuka

Mission Strengths

Our mission will tap into the global expertise and reputation of our members and the University in the education space by empowering researchers/students through Digital Science Mastery: This mission envision students, researchers and other stakeholders have access to the resources and support needed to thrive in the rapidly evolving landscape of digital science. Our initiative is committed to fostering a community of lifelong learners equipped with the knowledge and skills essentials for success in their digital endeavor.

Mission Objectives

This mission aims to achieve the vision through developing a range of education/training programs targeting different levels/types of audiences such as undergraduate/ postgraduate students, high-school students, researchers, and industry partners including executives. Through these training programs, it also anticipates the dissemination of DSI as the supporting framework within the digital science community.

Mission activities for 2023

This mission started its initial activity to define its mission and identifying the current landscape in the areas of technical training and public education in relation to digital science fields.

Mission Outcomes in 2023

Initiated the collaboration with the school of Business, who runs Executive Plus program, which can be used as one of frameworks to launch an education program targeting industry executives in the future.
The mission has also worked with the marketing team of the Faculty of Engineering to identify the possible collaboration activity with regards to faculty's outreach programs.

Planned activities for 2024

This mission plans to explore the potential development of AI-related boot camps and intensive workshops in collaboration with industry partners. The objective is to introduce cutting-edge enterprise platforms within the realm of Digital Science and AI/ML.

Strategic Objectives and Initiatives

We have identified six priority initiatives to be supported by the DSI that are designed to help us achieve our strategic objectives.

Interdisciplinary Research

Key Activities
- Grand Challenge Research Pilot Projects
- Digital Sciences Fellowships
- Seminar Series
- Annual Retreat
- DSI Colloquium
- Benchmarking
- Vacation Research

Industry Engagement

Key Activities
- Seed Projects
- Industry Advisory Boards
- Government Partnerships
- Large Scale Collaborative Research
- Commercialisation
- Community Engagement
- Internships

Partnerships

Key Activities
- International colloborations
- Digital Central
- AI and Data Capa- bilities Centres
- Centre of Excellence
- Data 61 AI and Machine Learning

Digital Education

Key Activities
- Digital Sciences Engineering Curriculum
- Executive Education
- Digital Literacy
- Micro-Credentials, Short Courses and Boot Camps
- Holiday Programs
- Internships

Digital Infrastructure

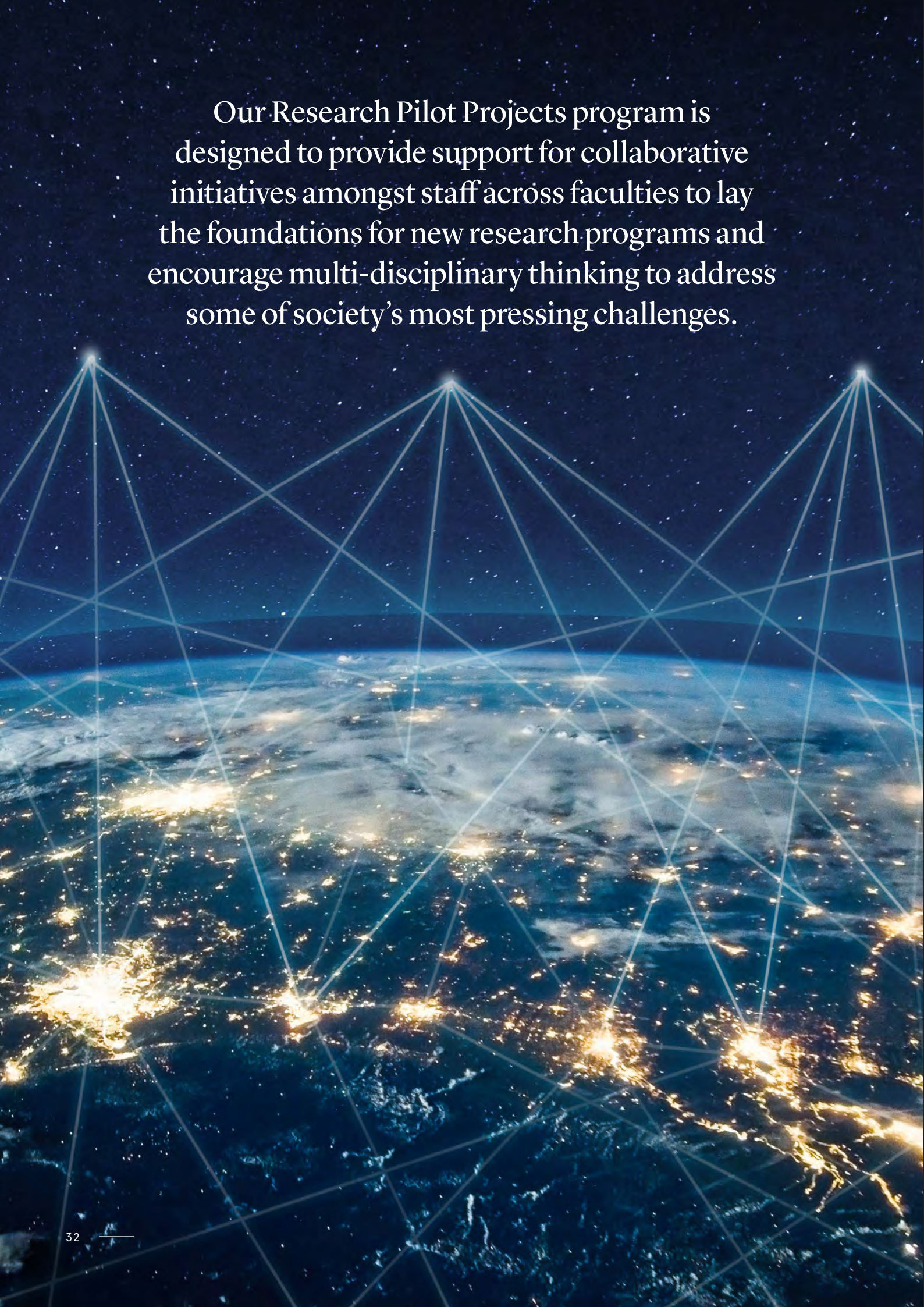### Key Activities
- Access to HPC
- Digital Sciences Hub
- Technology Infra-structure

People and Culture

Key Activities
- Outreach and Recruitment
- Mentorship and Support
- Curriculum and program design
- Diversity and inclusion training

Our Research Pilot Projects program is designed to provide support for collaborative initiatives amongst staff across faculties to lay the foundations for new research programs and encourage multi-disciplinary thinking to address some of society's most pressing challenges.

Interdisciplinary Research

Research Pilot Program

Our Research Pilot Projects program is designed to provide support for collaborative initiatives amongst staff across faculties to lay the foundations for new research programs and encourage multi-disciplinary thinking to address some of society's most pressing challenges. The key objective of the scheme is to engage researchers across the whole University to conduct rapid feasibility studies on transformative ideas in the digital sciences, with legal and societal impacts and questions built in from the ground up and develop these ideas into concepts or technologies that can attract further investment from government and/or industry. In 2023, eight pilot projects were funded.

Name	Project Title
Sheryl Chang	Digital epidemiology: Network-sensitive pandemic and opinion modelling with incomplete data
Qiang Tang	Frontiers on realizable regulatory studies of cryptocurrency
KanchanaThilakarathna	Social Situational Awareness
Anusha Withana	Augmented-Human Research and Engineering
Ali Hadigheh	Digitalising corrosion monitoring of structures by coupling new multi-functional optical sensing systems, machine learning techniques and digital twin models
Gwenaelle Proust	Optimisation of processing parameters for the fabrication of refractory alloy components for space applications using laser powder bed fusion technology
Xianghai An	Real-time anomaly detection in additive manufacturing processes using artificial intelligence
Daniel Dias-da-Costa	Computer vision inspection of structures in post-disaster scenarios

Digital epidemiology: Network-sensitive pandemic and opinion modelling with incomplete data

Project Lead

- Prof Mikhail Prokopenko, School of Computer Science (SCS), Faculty of Engineering

Project Participants

- Dr Sheryl Chang (SCS), Prof Tania Sorrell (FMH), Prof Alexandra Martiniuk (FMH), Dr Rebecca Rockett (FMH/CIDM), Dr Quang Dang Nguyen (SCS)
- Industry partners: Prof Vitali Sintchenko (NSW Health, Health Pathology-Institute of Clinical Pathology and Medical Research), Dr Carl Suster (Western Sydney Local Health District, NSW Health)

Mission - Digital Health

Objectives

- To develop an advanced computational framework for modelling opinion dynamics during pandemics integrated with the agent-based model (ABM). This framework has integrated the latest 2021 Australian Census data.
- To develop and integrate several methods for modelling dynamic opinion within the agent-based modelling. The updated software simulator allows dynamic opinion formation in response to pandemic progression, with multiple parameters governing risk evaluation, memory length, and extent of peer pressure.

Outcomes

This project facilitated The University of Sydney collaborations with the industry partners (Health Pathology-Institute of Clinical Pathology and Medical Research and NSW Health). Project progress was actively monitored through regular meetings scheduled bi-weekly in the past year. In addition to these online meetings, a workshop on Digital Epidemiology and Pathogen Genomics, was conducted in Westmead Hospital (September 22, 2023) to exchange latest research perspectives and findings from both sides and explore further collaborative opportunities.

The team completed three work components:

1. Generation of the artificial population datasets (25.4 million software agents), derived from 2021 Australian census (released by ABS in 2022), as well as other datasets: the Australian Curriculum and Assessment and Reporting Authority (ACARA) – for school students and teachers, and the Bureau of Infrastructure and Transport Research Economics (BITRE) – for international air traffic.

2. Open-source software update using the newly generated artificial population and latest air traffic data.

3. Open-source software update enabling re-infection and vaccine waning, with an integrated component for within-the-loop modelling of opinion dynamics.

The first two work components enabled a more accurate representation of current Australian population and have been used for developing the third work component with integrated opinion dynamics.

Key findings of the research were presented at various workshops and conferences, which attracted domestic and international interests from a diverse audience (e.g., public health, computational epidemiology, mathematical biology, etc.). The project resulted in 4 manuscripts (including one in preparation)

Publications

1. **Publication (open access):** Nguyen, Q. D., Chang, S. L., Jamerlan, C. M. & Prokopenko, M. *Measuring unequal distribution of pandemic severity across census years, variants of concern and interventions.* Population Health Metrics, 21, 17 (2023).

2. **Open-access dataset:** Q. D. Nguyen, S. L. Chang, C. M. Jamerlan, M. Prokopenko, *AMTraC-19 (v8.0) Dataset: Systematic Comparison of the COVID-19 Pandemic Scenarios,* released on 22 June 2023, Zenodo: https://doi.org/10.5281/zenodo.8067859.

3. **Open-source code of our pandemic simulator,** AMTraC-19, version 8.0: S. L. Chang, Q. D. Nguyen, C. Zachreson, O.M. Cliff, M. Prokopenko, AMTraC-19 Source Code: *Agent-based Model of Transmission and Control of the COVID-19 pandemic in Australia,* released on 22 June 2023, Zenodo: https://doi.org/10.5281/zenodo.5778218

4. **A manuscript in preparation,** to submit to IEEE Transactions on Computational Social Systems: Chang, S. L., Nguyen, Q. D., Jamerlan, C. M. Suster, C.J.E., Rockett, R. J. Sintchenko, V., Sorrell, T.C., Martiniuk, A. and Prokopenko, M., *Impact of opinion dynamics on recurrent pandemic waves: balancing risk aversion and peer pressure.*

Key findings of the research outputs were presented at various workshops and conferences, which attracted domestic and international interests from a diverse audience (e.g., public health, computational epidemiology, mathematical biology, etc.). Key events participated include:

- **Plenary talk:** *"How to quantify pandemic inequality?"* at Oceania Chapter of the System Dynamics Society "Systems Thinking & Modelling Symposium", Sydney, February 9, 2024 (Mikhail Prokopenko)

- **Webinar:** *"Measuring unequal distribution of pandemic severity across census years, variants of concern and interventions"* at AusCMI meeting "Reflecting on the last four years of COVID-19 discussions", November 7, 2023 (Mikhail Prokopenko)

- **Seminar:** *"Health vs Economy: a false choice of pandemic modelling",* at The Isaac Newton Institute for Mathematical Sciences (INI), University of Cambridge, UK, October 19, 2023 (Mikhail Prokopenko)

- **Seminar:** *"Multiscale Modelling of Behaviour-induced Critical Regimes during Epidemics"* at The Isaac Newton Institute for Mathematical Sciences (INI), Workshop "Connecting Micro to Macro in Epidemiological Models", University of Cambridge, UK, October 18, 2023 (Mikhail Prokopenko)

- **Workshop presentation:** *"Measuring unequal distribution of pandemic severity"* at the Emerging Aspirations workshop, The University of Sydney, September 29, 2023 (Dang Quang Nguyen)

- **Invited conference talk:** *"Measuring pandemic inequality in heterogeneous population"* at SIAM (Society for Industrial and Applied Mathematics) Conference on the Life Sciences (LS24), Portland, USA, June 10-13, 2024, forthcoming (Sheryl Chang)

- **Workshop presentation:** *"Quantifying pandemic inequality in heterogeneous populations"* at the Centre for Complex Systems workshop "Evolution of Social Complexity 2024", The University of Sydney, 21 February 2024 (Sheryl Chang)

- **Guest Lecture (online):** *"Modelling multiwave COVID-19 transmission and control in Australia"* at Whitworth University Winter School for Mathematical Biology, Washington, January 18, 2024 (Sheryl Chang)

Education/training outputs

Updated AMTraC-19 (v8.0) user guide available on Zenodo, released on 22 June 2023, URL (open source): https://doi.org/10.5281/zenodo.5778218

Frontiers on realisable regulatory studies of cryptocurrency

Project Leads

- Dr Qiang Tang, School of Computer Science, Faculty of Engineering
- Associate Professor Danny Gozman, USyd Business School

Project Participants

- Professor Daniel Schlagwein (USyd Business School)

Industry Participants

Protocol Labs, Stellar Development Foundation

Mission – Data Centric Engineering

Objectives

Objective 1 – (a) Economic and policy analysis of the current global regulatory environment for cryptocurrencies (CC) and proposed future directions of national policymakers and regulators world-wide, as well as institutions such as the World Bank, IMF and the Bank of International Settlements. (b) analysis of how Central Banks are formulating approaches to issuing their own Central Bank Digital Currencies (CBDC).

Objective 2 - Blockchain and cryptographic designs to enforce/realize regulations / policies (including existing ones and newly proposed).

Outcomes

Objective 1– Policy responses to Central Bank Digital Currencies and Cryptocurrencies by 68 Central Banks operating in different countries and Global Institutions (e.g., Basel, IMF, World Bank) were collected and analyzed with the help of a Research Assistant and Economic Consultant. This analysis explores the motivation of these policies and related technologies/architectures and business models. This data was taken at various snapshots in time as policy responses evolved. A third round of analysis of policy responses by these organizations is currently ongoing.

Objective 2– Various blockchain and cryptographic protocols for regulation, compliance, privacy preservation, and some new decentralized finance applications were designed and developed.

Collaborations

The two CIs and Professor Schlagwein had multiple discussions on potential deeper engagements on both policy design and corresponding technical designs, and decided to each work on policy designs and technical enforcements on existing policies independently first. When there is new policy/regulation designed, the team will come together to technically realize them later.

Media

- **Dr Qiang Tang** was interviewed by Ricardo Goncalave on SBS on "The Money Show" discussing cybersecurity issues.
- **Dr Tang** was also interviewed by ABC News on the Central Bank Digital Currencies and then on the Binance Case(largest cryptocurrency exchange).
- **Professor Daniel Schlagwein** has been interviewed by ABC, The Australian, Sydney Morning Herald, Australian Financial Review, The Australian and The Age on cryptocurrencies, cryptocurrency regulation, CBDCs and FinTech. Such as here:
  - ABC (web): Bitcoin miners are celebrating again but how long will this latest boom last? 2024-01-15
  - The Australian: ASIC loses key crypto case in court. 2024-03-14.
  - The Business (TV): Meet the bitcoin miners racing to crack codes as the cryptocurrency surges | The Business. 2024-03-11.
  - Australian Financial Review. 'What the Eff?': Jack Zhang on Airwallex's Near-Death Experience. October 26, 2023. (interviewed, research featured)

Outreach

The team hosted distinguished guest Professor Bart Preneel, from KU Leuven who was invited to give a talk in the DSI seminar series.

Conferences

For technical mechanisms to enforce existing regulations on private payment, we have several research outcomes, some of which would be instrumental for cryptocurrency or conventional commodity exchange, when adding privacy protection.

- **Ya-Nan Li, Tian Qiu, Qiang Tang**, *Pisces: Private and Compliable Cryptocurrency Exchange*" was published in The Network and Distributed System Security Symposium (NDSS) 2024, a top (CORE A*) computer security Symposium, 26 Feb–1 Mar 2024, in San Diego, California.
- **Tian Qiu, Qiang Tang**, *Predicate Aggregate Signatures and Applications*" was published in ASIACRYPT 2023, (CORE A), one of three flagship conferences of cryptography. Dec 4-8, 2023, Guangzhou, China
- *"Dragon: Decentralization at the cost of Representation after Arbitrary Grouping and Its Applications"* submitted to PODC 2024 (CORE A*), the top distributed computing venue, 17 June to 21 June 2024, Nantes, France.
- Work is underway on *"Cryptographic Protocols Enabling Dark Pool on cryptocurrency Exchange"* which will be submitted soon.

- Under review: Schlagwein, D., Gozman, D., Manusu, A., Low, G. (EJIS 242971653) 'Frames of Reference for Cryptocurrency Adoption: The Revelatory Case of Bitcoin'. European Journal of Information Systems. [ADBC top category] **Gozman and Schlagwein have presented this work earlier to the Governance Institute of Australia.**
- Schlagwein, D. (2023). 'Supporting Students' Hands-On Understanding of Blockchain Concepts with 'The Crypto' Game'. International Conference on Information Systems (ICIS). Hyderabad, India, Dec 10-13, 2023. [CORE top category]

Education / training outputs

Dr Qiang Tang developed some relevant privacy preserving cryptocurrency content for COMP5617, which will be further refined and integrated.

The Crypto (Professor Schlagwein) has been nominated for both the USYD Business School teaching award (innovators category), and has been successfully used in MCom, MBA, and EMBA courses, and materials have been shared with colleagues worldwide.

Social Situational Awareness

Project Lead

- Dr Kanchana Thilakarathna, School of Computer Science, Faculty of Engineering

Project Participants

- Professor Justin Hastings and Dr Aim Sinpeng, Department of Government and International Relations, Faculty of Arts and Social Sciences
- Dr Suranga Seneviratne, Associate Professor Piravenan Mahendran and Professor Albert Zomaya, School of Computer Science, Faculty of Engineering

Mission- Defence

Objectives

To study the social media landscape related to "Voice Referendum" due to its timeliness, interest from Australian security agencies and impact on Australian society. The following objectives were achieved:

- Development of a multi-modal data collection framework that can collect social media data for longer campaigns and construct a dataset from the beginning to the end of the campaign.
- Investigate the relevance and impact of social media in the outcome of the Voice Referendum.
- Development of machine learning models to early detect influence operations, belief dynamics and outcome of social media campaigns.

Outcomes

The Voice Referendum was the first referendum held in Australia since the dawn of social media, so provided a unique opportunity to investigate the relationship between referendums in Australia, and social media. As social media platforms increasingly shape and amplify public discourse, questions emerge regarding their influence and concurrence with polling data over time. This research delves into the evolving relationship between social media and public polling in the 2023 Voice Referendum in Australia. By modelling user belief dynamics leveraging AI and then examining trends, patterns, and shifts in both social media engagement and polling outcomes over time, this research elucidates the complex interplay between these two spheres and their impact on the referendum or broader election outcomes.

The data modelling and analysis were started after the Voice Referendum in October 2023. As a result, the research outcomes are delayed at the time of this report.

Presentations

The project was presented as an example multi-disciplinary project to Defense agencies in the USA during the Faculty of Engineering visit to Washington D.C. in July 2023, and in February 2024. This has resulted in further discussions with Army Research Labs, DARPA and Office of Naval Research in the USA.

Engagement, collaborations and future funding

- The team is currently in discussion with Defence agencies in the USA on submitting a proposal related to influence pathway modelling.
- The project has also led to start a collaboration with University of Maryland and Colorado State University on the same topic.
- The team expected to submit a proposal to upcoming ONI-ARC grant scheme at the end of 2024.

Augmented-Human Research and Engineering

Project Lead

- Dr Anusha Withana, School of Computer Science,

Project Participants

- Professor Alistair McEwan, Professor Ken-Tye Yong, Professor Gregg Suaning and Associate Professor Omid Kavehei, School of Biomedical Engineering, Faculty of Engineering,
- Dr Zhanna Sarsenbayeva, Dr Kanchana Thilakarathna, Professor Zhiyong Wang, Dr Andre van Renssen and Professor Joachim Gudmundsson, School of Computer Science, Faculty of Engineering
- Associate Professor Craig Jin, School of Electrical and Information Engineering, Faculty of Engineering

Industry Participants

ARIA Research (NHMRC Ideas Grant)

Mission - Digital Health, Defence, Advanced Manufacturing and Materials

Objectives

This project aims to use computational fabrication technologies to create transformative wearable and implantable devices that can be used for monitoring, feedback, and prediction of human activities, including physical, physiological, and biochemical modalities. The key objectives were:

- Develop an analytical framework to support the computational fabrication of wearable and implantable augmented human technologies to fit the application and user needs. Within the scope of this project, the engineering team aim to develop several prototype devices through computation fabrication.
- Develop co-design interfaces that synthesize primitive sensing and interface needs into complex devices to fit individualized problems using parametric modelling and machine learning. The engineering team will collaborate with the interdisciplinary CIs to create co-creation interface.
- Validate the framework through the digital fabrication of prototypes and evaluate in different application areas by deploying the sensors in real-world settings and gathering data. The interdisciplinary team will work together to evaluate several application demonstrators.
- Create a collective track record between key participants.

Outcomes

With the seed funding, we have developed analytical frameworks for different aspects of human activities ranging from movement modeling to physiological modelling such as cardiac activities. We have applied this knowledge to create novel fabrication methods for sensors and used co-design tools to allow non-tech experts to engage in the design process. We have validated the performance of these augmented human technologies with in-lab user studies and aim to complete the real-world studies in near future.

3D- printed electrode design with different number of pins

3D printed sensors - left to right- sensor bracelet, in-sole sensor for gait analysis and sensor band to track arm movements.

Collaborations

Built a network of collaborators outside USyd, including industry partners:

- Professor Paul Hodges from UQ
- Professor Mark Billingshurst from UniSA
- CI Withana and Professor Billingshurst will co-organize the flagship augmented humans conference together in 2024.
- Prof CT Lin (UTS) - already secured external funding together.
- Prof Gaetano, and Prof Breen (WSU), collaborative grant submitted.
- The Cerebral Palsy Alliance of Australia
- Dr Mirklaf (UQ) – already published papers.

International collaborators

- Professor Sri Subramanian (UCL, UK)
- Professor John Rogers (Northwestern, USA).
- Professor Sugiura Keio (Japan)

Publications

- J Yu, PB Perera, RV Perera, M Mirkhalaf, A Withana, *Fabricating Customizable 3D Printed Pressure Sensors by Tuning Infill Characteristics*, IEEE Sensors Journal, 2024
- Adele Tong, Praneeth Perera, Zhanna Sarsenbayeva, Alistair McEwan, Anjula C De Silva, Anusha Withana *Fully 3D-Printed Dry EEG Electrodes*, Sensors, 2023
- Burne, Lachlan, Chiranjibi Sitaula, Archana Priyadarshi, Mark Tracy, Omid Kavehei, Murray Hinder, Anusha Withana, Alistair McEwan, and Faezeh Marzbanrad, "*Ensemble Approach on Deep and Handcrafted Features for Neonatal Bowel Sound Detection.*" IEEE Journal of Biomedical and Health Informatics (2023).

Conference

- Zhanna Sarsenbayeva,Charlie Fleming, Benjamin Tag, Anusha Withana, Niels van Berkel, Alistair McEwan, *A review on mood assessment using smartphones*, - IFIP Conference on Human-Computer Interaction, 2023
- Hasindu Kariyawasam, Amashi Niwarthana, Alister Palmer, Judy Kay, and Anusha Withana. *Appropriate Incongruity Driven Human-AI Collaborative Tool to Assist Novices in Humorous Content Generation*, In 29th International Conference on Intelligent User Interfaces (IUI '24), March 18–21, 2024, Greenville, SC, USA. ACM, New York, NY, USA,

Funding opportunities leveraged/ planned through the DSI Pilot project

- External : NHMRC Ideas grant: AU$ 1.6M (2023 - 2026), "*Fluent Mobility for the Blind Individual Using Multimodal Auditory Sensory Augmentation*" with UTS (CI Associate Professor Craig Jin)
- https://www.grants.gov.au/Ga/ Show/5fb15447-4f04-4df8-b2c8-8cdf26e88a4f
- Internal: USyd CAPEX grant (CI Withana with DSI Pilot participants): "*Co-De-in-VR Lab: Co-Design in Virtual Reality Training and Research Facility*" - $238,563
- Planned: ITRP in 2024

Digitalising corrosion monitoring of structures by coupling new multi-functional optical sensing systems, machine learning techniques and digital twin models

Project Lead

- Dr Ali Hadigheh, School of Civil Engineering, Faculty of Engineering

Project Participants

- Professor Simon Fleming and DrIvan Rukhlenko,Faculty of Science
- Professor Marjorie Valix, School of Chemical and Biomolecular Engineering (CBE)
- Professor Xiaoke Yi, School of Electrical and Information Engineering

Industry participants

Transport for NSW (TfNSW)

Mission - Data Centric Engineering and Advanced Manufacturing and Materials

Objectives

The scale of structural deterioration worldwide and the inadequacy of current non-destructive evaluation techniques necessitate the adoption of accessible, quantitative, continuous structural health monitoring (SHM) technology into mainstream asset management practice. The project objectives were:

- Develop advanced fibre optics (FO)
- Carry out laboratory tests on reinforced concrete samples
- Establish machine learning models for structural analysis of strain, temperature and durability factors
- Field test and data analytics
- Develop a digital twin model of a selected bridge

Outcomes

This work addressed the significant demand for SHM technology by successfully developing in-house optical fibres for corrosion monitoring in concrete structures and work is under progress, to further tailor the Fibre Optic Sensor (FOS) by adding a smart sensing layer to the FOs. Government partner, Transport for NSW (TfNSW), has agreed to implement the Fiber Optic Sensors (FOS) on a bridge and the field test will be conducted in 2024.

Traditionally, in industry, addressing temperature effects on strain requires using separate sets of FOSs—one for strain and another for temperature sensing. In this project, the team devised a machine learning model that detects strain and temperature effects simultaneously, utilising only a single fiber Bragg gratings (FBGs) sensor. This innovation allows industries to eliminate one set of sensors, reducing costs and simplifying installation procedures.

Our collaboration with chemists from CBE has resulted in intelligent sensing coatings for Fiber Optic sensors, offering high sensitivity to monitor moisture, pH/ corrosion and chemicals near steel reinforcement, enabling comprehensive corrosion monitoring in reinforced concrete structures. This technology can revolutionize infrastructure maintenance and safety and we are currently seeking industry partners and funding to progress to the next step.

Collaboration and Engagement

Our industry partnerships have been expanded and we have been successful in securing a SmartCrete CRC Industry-Led Research Collaborations Fund in 2024, collaborating with TfNSW and Parchem (**https://www. parchem.com.au/**). As part of this project, we will also trial our developed FOSs for monitoring steel corrosion in cathodic protection systems.

Collaboration was established with Prof Ganga Prusty from UNSW Sydney. This work involves the development

of an innovative machine learning (ML)-assisted intelligent multi-parameter sensing system. This system enables simultaneous detection of strain and temperature effects based on a single fibre Bragg gratings (FBGs) sensor, aiding in in situ structural health monitoring (SHM) for automated fibre placement in fibre-reinforced polymer composites. Currently, preliminary analysis is underway, and plans are in place to submit a journal paper and funding application in 2024.

Furthermore, discussions have been initiated with various industry partners like EngAnalysis and Freyssinet for the investment on and the adoption of the developed optical sensors for corrosion monitoring of steel reinforcement in their respective projects

Publications

A paper was submitted to the Journal of Civil Structural Health Monitoring, pending review

Media

Dr Hadigheh was interviewed by news.com.au for his work on Smart sensors for bridge defects that was partly funded by this project.

Optimisation of processing parameters for the fabrication of refractory alloy components for space applications using laser powder bed fusion technology

Project Lead

- Professor Gwenaelle Proust, School of Civil Engineering, Faculty of Engineering

Project Participants

- Professor Zhiyong Wang and Associate Professor Tongliang Liu, School of Computer Science. Faculty of Engineering
- Cecilie Funch, School of Civil Engineering, Faculty of Engineering
- Romar Engineering (Industry)

Mission – Advanced Manufacturing and Materials

Objectives

To develop new Nb alloys for additive manufacturing for applications in the aerospace industry.

Outcomes

Successfully worked on developing design of experiment (DOE) for pure niobium and develop processing parameters for laser powder bed platforms. A full literature review on the subject was completed. The DOE parameters were tested on pure Nb showing at best 95% density. The DOE is currently being revisited to refine the parameters for the best results. Initial work involved collaboration with Romar Engineering. This work also started a collaboration with UNSW for the modelling work to develop new alloys using ThermoCalc.


First Batch of pure Nb specimens produced on the laser powder bed platform (Concept Laser MLab) in SMH

Publications

A review paper on refractory alloys with Cecilie Funch as first author will be submitted to Additive Manufacturing in March 2024.

Conference

Professor Proust gave a Keynote presentation and Cecilie an Invited presentation at the 11th Pacific Rim International Conference on Advanced Materials and Processing (PRICM11) in Jeju, Korea, in November 2023 supported by DSI through this project. This was a great opportunity to network and discuss our project.
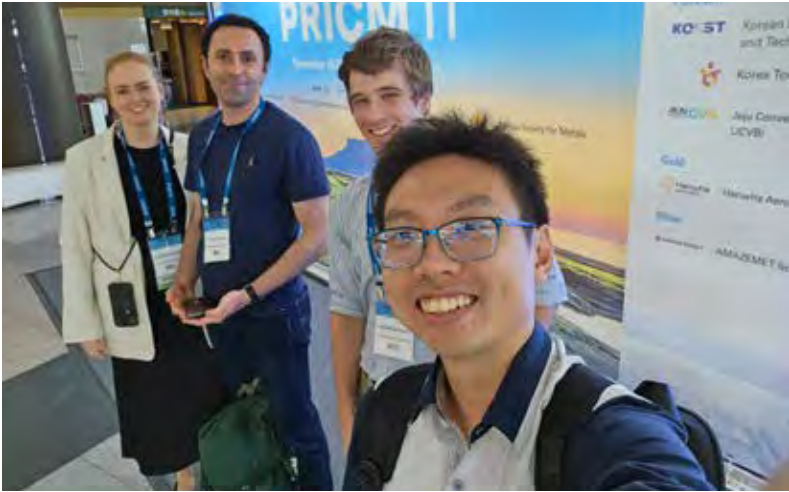
Some of the University of Sydney participants to PRICM11. From left to right: Dr Cecilie Funch, Associate Professor Mohammad Saadatfar, Mr James Warner (PhD student) and Dr Wen Hao Kan.

Real-time anomaly detection in additive manufacturing processes using Artificial Intelligence

Project Lead

- Dr Xianghai An, School of Aerospace, Mechanical and Mechatronic Engineering (AMME)

Project Participants

- Professor Gwénaëlle Proust, School of Civil Engineering
- Professor Qing Li and Dr Li Chang School of AMME,
- Associate Professor Zhiyong Wang, School of Computer Science,
- Dr James Haley, Oak Ridge National Laboratory (RA)

Mission - Advanced Manufacturing and Materials

Objectives

The project aims to develop an imaging system for real time in-situ monitoring of the laser powder bed fusion additive manufacturing fabrication process and develop new ML algorithms for solving multiple real-time anomaly detection problems with high accuracy. The improved setup can significantly enhance the manufacturing efficiency, reduce 3D printing waste and improving sustainability, cost and reliability.

Outcomes

The project was successful in accomplishing several technical objectives that include hardware and software licensing and deployment of the Peregrine AI tool. This enables real-time monitoring of defects in laser powder bed fusion additive manufacturing on the Concept Laser M2 at the Sydney Manufacturing Hub (SMH) using an off-axis high resolution camera. In addition, a software feature was developed for Peregrine which creates a real-time image composite of deposited material at a constant time offset from deposition for use in Digital Image Correlation to quantify deformation in AM. The established software package can now serve to provide researchers or users of the SMH facility with richer insights as to the performance of the printer and the quality of the component.

Collaborations

The pilot project partially sponsored a collaboration between the Sydney Manufacturing Hub and the Oak Ridge National Laboratory (ORNL) Manufacturing Demonstration Facility (MDF) through funding a research sabbatical / postdoctoral position for a MDF staff member to install, configure, and train SMH staff on the in-situ AI tool. The collaboration has brought an established AI driven digital quality management tool into the hands of USyd researchers.

Publications

A journal paper contrasting the traditional camera-based DIC and the application of the developed photodiode based deformation measurement method has been drafted, and will be submitted pending finalization of experiments and analysis.

Education/training outputs

This project hosted a student under the Summer Research Internship Program.

Fig. (a) Off-axis high resolution monochrome camera installed to view the printed surface of the LPBF system. (b) The Peregrine AI software interface, displaying real-time semantic segmentation of printed components, soot, and other defect classes.

Computer vision inspection of structures in post-disaster scenarios

Project Lead

- Associate Professor Daniel Dias-da-Costa, School of Civil Engineering, Faculty of Engineering

Project Participants

- Professor Luming Shen and Mr. Elyas Asadi Shamsabadi, School of Civil Engineering, Faculty of Engineering,
- Dr Chang Xu, School of Computer Science, Faculty of Engineering

Mission - Advanced Manufacturing and Materials

Objectives

To automatically process digital data taken from civil structures such as bridges and roads- and produce concise textual information that can describe critical situations e.g. landslides after flooding blocking roads. The project is composed of the following different stages (1) Literature review (2) Data collection, annotation, and pre-processing: Training, validation and testing of the data-driven models with adaptive generalisation over a wide range of unprecedented situations, rich datasets developed under fair machine learning rules. (3) Designing, running, and testing a machine learning pipeline for automatic image processing and captioning: Design of a pipeline to maximise the accuracy of the models in uncontrolled environments, such as the ones found in post-disaster scenarios. (4) Designing, running, and testing a machine learning pipeline for text processing. (5) Real-time application of the proposed models with the drone technology for condition mapping. The trained models in stages 2 and 3 are used to create a light pipeline for real-time processing on edge devices.

Outcomes

The funding enabled the resolution of key bottlenecks in the practical implementation of machine learning for infrastructure damage detection, particularly in uncontrolled environments, by addressing the scarcity of labelled datasets. A semi-supervised framework was developed, marking a significant breakthrough, as it achieved a remarkable reduction of up to 98% in required labelled data without compromising detection accuracy, which remained consistently high and within a 5% difference compared to benchmark data. These promising results suggest that the proposed framework holds potential for real-world deployment.

Furthermore, the team identified the need for real-time processing for edge devices and addressed this by developing the lightest model documented in the literature, enhancing computational efficiency while maintaining robustness and effectiveness in damage detection. This model lays a solid foundation for further advancements in real-time damage segmentation on edge devices. Anticipated developments suggest the imminent presentation of a framework capable of real-time damage segmentation in post-disaster scenarios, further progressing under tasks (4) and (5).

Collaborations and Engagement

Established collaborations with colleagues at the Sydney School of Architecture, Design and Planning via Dr Anastasia Globa and Dr Ariana Brambilla. Held several meetings with the NSW State Emergency Service (SES) with the intent to develop the framework for practical deploying in regions of high risk of flooding and anticipate an application with SES, NSW, for the $2.1b Digital Research Fund.

Publications

- Elyas Asadi Shamsabadi, Seyed Mohammad Hassan Erfani, Chang Xu, Daniel Dias-da-Costa, *Efficient semi-supervised surface crack segmentation with small datasets based on consistency regularisation and pseudo-labelling*, Automation in Construction, Volume 158, 2024, 105181 (doi: 10.1016/j.autcon.2023.105181)
- Zhaohui Chen, Elyas Asadi Shamsabadi, Sheng Jiang, Luming Shen, Daniel Dias-da-Costa, *An average pooling designed Transformer for robust crack segmentation*, Automation in Construction, Volume 162C, 105367, 2024

Conference

- Globa, A., Asadi Shamsabadi, E., Dias-da-Costa, D., Liu, Z., Brambilla, A., Shen, L., Reinhardt, D., Keane, A., Davies, P., *"City Meta Twins – Building Resilience"*, Network 4 Sustainable Nanotechnology Global Summit 2023, Sydney, Australia, November 27 – 29th, 2023.

Seed Funding Program

The purpose of the DSI Seed Funding is to identify key digital challenges facing industry and to stand up teams of researchers to undertake fundamental and applied research focused on addressing these issues. The program comprises three stages, designed to facilitate a workflow from initial concept exploration (Stage 1), through an initial scoping or feasibility study (Stage 2) and culminating in external grant development support (Stage 3) for the preparation of proposals or tenders for large scale collaborative funding opportunities. Our first round of Call for Problem Statements in early 2023 sparked considerable interest from potential industry partners and our academics. We have worked with over a dozen industry partners to develop problem statements and workshop collaborative opportunities on topics ranging from Health, Food Retail, Defence, Energy and Aerospace.

DSI Seed Project Grant Scheme, Stage 1

Successful recipients

Name	Project Title
Professor Salah Sukkarieh	Horticulture Digital Twin for Improving Farm Operations
Professor Salah Sukkarieh	A Unique Phenotyping Robot for Precision Seed Selection and Seed Placement for the Vegetable Industry
Associate Professor Zhiyong Wang	Workshop on Space AI Agriculture
Dr San Seint Seint Aye	Artificial Intelligence-Assisted High-Content Cell Imagining System
Professor Jennifer Whyte	Project Analytics: The role of analytics in engineering decision making
Dr Yao Wang	Artificial Intelligence enhanced high-content single cell technologies for mechano-medicine profiling

The DSI seed funding was designed to have 3 stages - initial concept exploration, scoping or feasibility study and culminating in external grant development support for large scale collaborative funding opportunities.

> "As a new academic at the university, DSI has been particularly helpful in connecting me with potential collaborators and industry partners. The DSI brought together myself, another academic in engineering, and GE, then provided seed funding that kickstarted a project. The outcomes of that project are now the basis of discussions about a linkage grant and expanded collaboration with GE. None of this would have happened without DSI connecting and supporting us."

Dr Jonathan K. Kummerfeld

DSI Seed Project Grant Scheme, Stage 2

AI-aided NLP and other methodologies to automate onboarding EMS parameter mapping into the GE Aerospace data visualisation tool

GE Aerospace

Flight data is recorded in airline-specific, aircraft-specific, and even flight-specific structures, with labels written by airline engineers. To provide a unified view of this data in GE Aerospace services, this project identified a mapping from these labels onto a unified set of GE Aerospace defined categories. This task is currently completed manually.

The goal of this project was to explore the potential for AI-based methods to be part of this parameter mapping process. Doing so opens significant possibilities for GE Aerospace including:

1. Improving efficiency within GE Aerospace by reducing the amount of employee effort in creating these mappings.
2. Enhance the reliability of current product offerings, by improving the accuracy of the data processing methods within the company.
3. Acquiring new customers by creating a website where they can provide their own data and instantly see a demonstration of how it would appear in the GE Aerospace analysis suite.
4. Provide a platform from which to build new digital GE Aerospace products using AI-based methods, for maintenance, training and safety management software.

The system developed through the collaboration has achieved results that the model can maintain current accuracy levels while reducing the amount of work for people by a factor of 10. The model also has the potential to identify human errors.

This project was intended to pro-actively explore collaboration opportunities between GE Aerospace and The University of Sydney (USyd) led by team Associate Professor Nicholas Lawson. As a first step, GE Aerospace provided data and guidance for the project, while the Digital Sciences Initiative (DSI) at USyd provided funding for research assistants and also helped establish links with suitable academic staff, in Aeronautical Engineering and Computer Science.

Faculty:
- Assoc. Professor Nicholas Lawson
- Dr Josiah Poon

- Dr Jonathan K. Kummerfeld

Students:
- Yidong Gan
- Alexander Jephtha

DSI Seed Project Grant Scheme, Stage 3

ITTC Workshop on Propulsion Systems and Launch Capabilities

The 2nd Co-design Workshop for the Industrial Transformation Training Centre (ITTC) on Propulsion Systems and Launch Capabilities was held in the Sydney Knowledge Hub on Monday 21 August. The centre proposal is being led by Matthew Cleary (AMME) and is supported by the Digital Sciences Initiative with a collaboration between the Data-centric Engineering, Defence and Advanced Manufacturing and Materials missions.

The workshop, was well supported by Industry, government and the defence sector with over 80 attendees (online and in person) The three industry panel sessions and the plenary focused on issues critical to the establishment of a sovereign propulsion and launch industry to support strategic defence and space needs.

ITTC Grant Application Submission

With the support of a DSI Seed Project Grant Scheme (Stage 3), Professor Fernando Calamante together with colleagues from the DSI Digital Health Imaging mission (Associate Professor Luping Zhou, Professor Jinman Kim, Dr Andre Kyme, Dr Sasha Rubin, Dr Ryan Sullivan, and Dr Chenyu Wang) submitted a grant application for the ARC Industrial Transformation Training Centres scheme. Their "ARC Training Centre for AI Medical Imaging Transformation (AIMIT)" application is a collaboration with The University of Queensland (led by Professor Markus Barth), Monash University (led by Associate Professor Zhaolin Chen), and 12 industry partners from across the spectrum of medical imaging. The Training Centre aims to transform Australia's Medical Imaging industry by providing a new generation of AI Imaging Change Leaders who will link research and innovation in academia to industry.
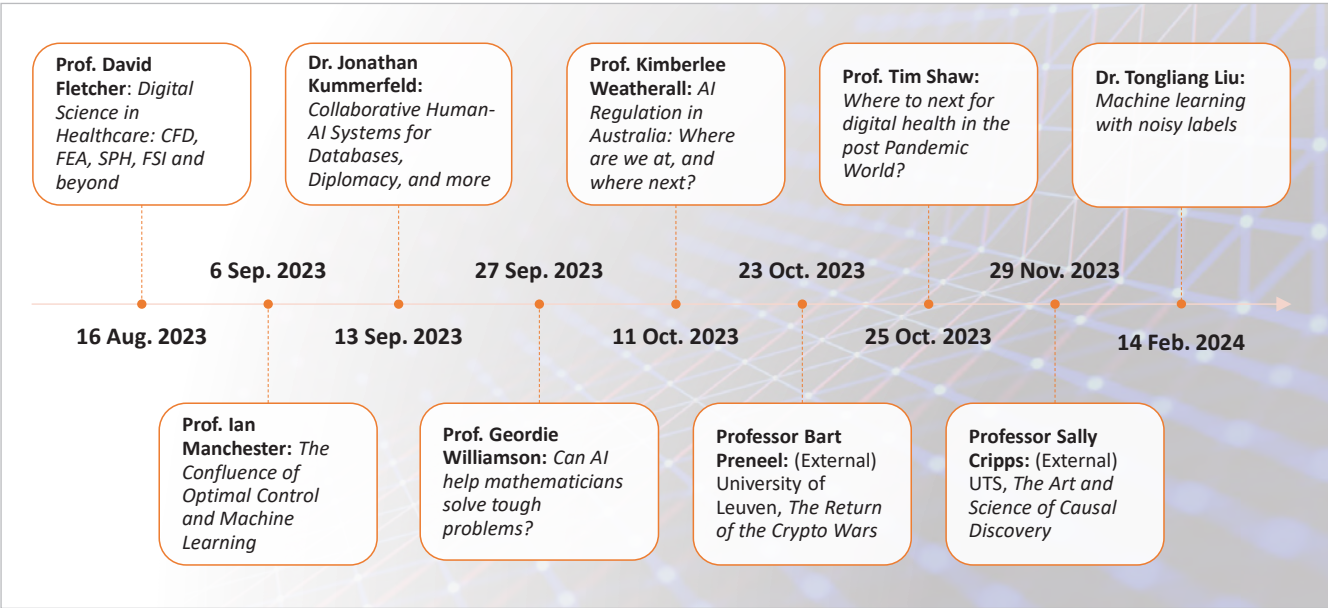
The DSI seminar series is designed to facilitate a platform for multidisciplinary ideas to converge and provide networking and collaboration opportunities.

DSI Events and Initiatives

DSI Seminar Series

The DSI seminar series was launched in August 2023 for our academics to present their research and interests to colleagues and encourage discussions and networking across the university community and within missions. The seminar series featured 8 talks in 2023, covering a diverse range of topics including digital health, natural language processing, fundamentals of neural networks, legal frameworks around AI and probabilistic planning. Our speakers included both internal and external academics. This series has facilitated a platform for multidisciplinary ideas to converge and is designed to provide networking opportunities. More details of the seminar series can be found here.

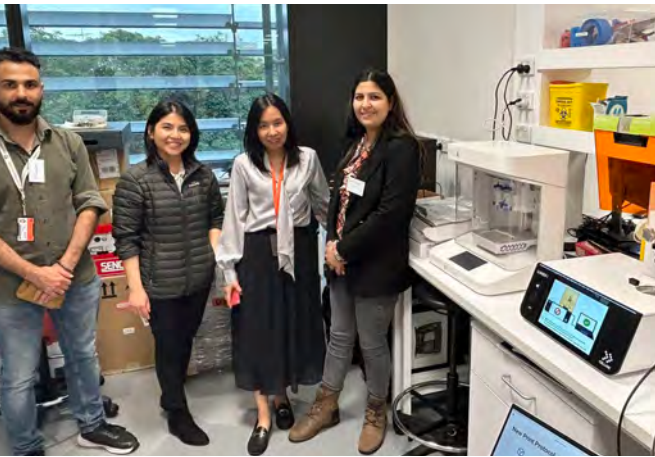Timeline of the DSI Seminar events with the list of speakers and the subject of the talk in the box

AI for Good Global Summit

Professor Salah Sukkarieh presented his work at the **AI for good conference** (Tuesday 5th – 7th July 2023) to a global audience and had the stand up and running. The event went extremely well leading to lots of important contacts that would support both the collaboration efforts and potential funding. Importantly there were EU commission and government officials. This was followed by another trip to UN FAO in Rome with more of a focus on Ag Engineering / Robotics and Professor Sukkarieh chairing two sessions for the UN on mechanisation, robotics and AI (**https://www.fao.org/events/detail/global-conference-on-sustainable-agricultural-mechanization/en**). DSI's support was crucial in facilitating these opportunities including transportation of the Digital Farmhand.

DSI Agriculture – Narrabri Field Day

On the 19th of Sept 2023, the Digital Agriculture team in partnership with the Sydney Institute of Agriculture participated in the annual Narrabri Field day at the I. A. Watson Grains Research Centre. The team showcased the capabilities of their robots – the Digital Farmhand and the Swagbot which can perform autonomous soil sampling and route following. The demonstrations attracted great interest from participants that included high school students and industry representatives.

Industry Collaboration Workshop

Dr San Seint Seint Aye, one of the recipients of the DSI Stage 1 seed grant, hosted a very successful workshop on *3D Bioprinting and Bioimaging analysis* at the Charles Perkins Centre (CPC) on 23 August 2023 supported by DSI.

The workshop included presentations by Associate Professor Khoon Lim, Dr Xiao Kuang (Harvard Medical School) and Dr Ann-Na Cho (Macquarie University). Representatives from AXT Pty Ltd showcased bioprinters and latest methods/tools for tissue engineering solutions that can help develop inspire future tissue engineering solutions and stimulate possible collaboration with leading researchers and industry partners. The one–day workshop was concluded with hands on demonstrations and lab tours that were well received.

Indo Pacific 2023

The DSI team was actively involved in supporting the University of Sydney's booth at the Indo Pacific 2023 International Maritime Exposition, 6th–9th Nov 2023. The Autonomous Underwater Vehicle and additive manufacturing samples from the Sydney Manufacturing Hub were highlights and attracted considerable interest from delegates. The DSI team was also involved in a range of industry and government tours to showcase our labs and capabilities to international guests who were visiting Sydney for the expo. More details here.
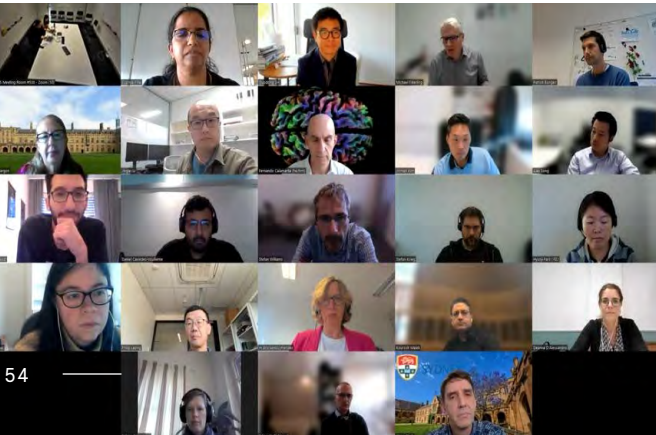
DSI Digital Innovation Teaching Workshop

DSI Digital Innovation Teaching Workshop Our distinguished guest, Professor Rolando Chacon from Polytechnic University of Catalonia (UPC), led an interactive half-day workshop in November 2023 on innovation in teaching using digital twin representations of objects through measurement. He demonstrated his innovative digital teaching tools that he has Events developed over the past decade. Participants included a diverse cohort of research students and academic staff from across the University of Sydney and UNSW who were engaged in a fun and informative experiment using the digital tools provided to them. Through this workshop, participants gained hands-on experience and a deeper understanding within the realm of Digital Twin representation in teaching.

DSI Seminar Series

The DSI seminar series was launched in August 2023 for our academics to present their research and interests to colleagues and encourage discussions and networking across the university community and within missions. The seminar series featured 8 talks in 2023, covering a diverse range of topics including digital health, natural language processing, fundamentals of neural networks, legal frameworks around AI and probabilistic planning. Our speakers included both internal and external academics. This series has facilitated a platform for multidisciplinary ideas to converge and is designed to provide networking opportunities. More details of the seminar series can be found here.

Collaboration meeting with Germany

An online collaboration meeting with Forschungszentrum Jülich in Data Science and Simulation through their initiative CASA – Center for Advanced Simulation and Analytics was held on the 23rd of Nov. Julich formed part of the Helmholtz delegation that visited USyd in March 2023 and expressed their interest to engage more closely with the DSI activities. CASA is organised in so called CASA Simulation and Data Labs (SDL) in which cross-disciplinary teams work on research questions from application areas including Neuroscience, Climate Science, Energy Materials, Quantum, Healthcare, Bioeconomy to name a few. The meeting was well attended by members of the DSI and NZI teams.

DSI Retreat

We held our DSI retreat at the Fairmont Resort,Leura in the Blue Mountains on the 13th and 14th of Nov with over 50 academics representing all faculties in attendance. It was a very successful event with panel sessions focused on external engagement, discussions on Mission strategies, multidisciplinary grand challenge pilot projects, fundamental research focus areas, opportunities for our Digital Sciences Education program and team building activities. The input gathered from the retreat will be used to formulate our goals and plans for 2024.

Engineering Vacation Research Internships

The Engineering Vacation Research Internship (VRI) program is open to students interested in pursuing a research career at a university or in industry. It is designed to provide students valuable engineering, computer science and project management research experience by working on real projects alongside respected and accomplished key researchers at the University of Sydney.

Aligning with the strategy, DSI supports research, training, and engagement opportunities with a focus on excellence, scale and impact and looking to support young minds with interest in the digital sciences and technology to benefit from this multidisciplinary initiative and make an impact. In 2023, the Digital Sciences Initiative offered 9 scholarships during Winter and Summer programs. These scholarships are aimed at providing the necessary skills and training to our students to advance their digital technologies careers. The anticipated outcomes are:

- Contribute to a greater research culture for Engineering students
- Assist in the recruitment of PhD students
- Assist project supervisors in their research

The Dec 2023 networking for VRI students kicked off with a spotlight on DSI presented by director Professor Stefan Williams. The subsequent events featured talks by DSI members Dr Clement Canonne and Professor Gwenaelle Proust.

Professor Stefan Williams addressing the VRI students at the networking event in Dec 2023

Vacation Program and year	Name	Project No. and Name	Supervisor/s
Summer 23–24	Chun Kit Li	Cross-modal medical image generation	Prof Jinman Kim
Summer 23–24	Andrea Bosia	Reconstructing Natural Image from Brain Activity	Dr Jinglei Lv, Zhiyong Wang, Prof Fernando Calamante
Summer 23–24	James Douglas	AI and NLP: Healthcare	Dr Jonathan K. Kummerfeld
Summer 23–24	Shuchang Ye	Cross-modal medical image generation	Prof Jinman Kim
Summer 23–24	Xiao Ming Zhu	Read the mind with simultaneous EEG-fMRI.	Dr Jinglei Lv, Associate Professor Mayuresh Korgaonkar, Professor Fernando Calamante
Summer 23–24	Yue Wang	Predictive Gesture Classification in Virtual Reality (VR)	Dr Anusha Withana
Winter 2023	Woraman Losereewanich	Accelerated Real-Time Image Processing Pipeline for Embedded Systems on Marine Robots	Prof Stefan Williams, Dr Gideon Billings
Summer 22–23	Guansong Pang	Service life prediction of infrastructures with machine learning	Ali Hadigheh
Summer 22–23	Yiyu Xie	Design of concrete mixtures with machine learning and artificial intelligence tools	Daniel Dias-da-Costa and Luming Shen

DSI Key Member Achievements

Awards

AI 10 to Watch

Associate Professor Tongliang Liu from the School of Computer Science won the <u>AI's 10 to Watch Award</u> and the <u>Eureka Prize for Emerging Leader in Science</u>.

CSIRO AI Programs

Professor Jennifer Whyte won one of the <u>Artificial intelligence programs</u> awarded by CSIRO. Professor Whyte will be working along with other chief investigators from RMIT and Westmead Private Hospital to help a cohort of graduates gain highly necessary skills in AI to support critical infrastructure and community safety.

Young Tall Poppy Science Award

Dr Clement Canonne (School of Computer Science) received the NSW 2023 <u>Young Tall Poppy Science Award</u>. "Tall Poppies". This award recognises achievements of Australian scientists for their outstanding track record and the impact of their outreach activities and promoting an understanding and appreciation of science in the broader community.

Materials Australia Silver Medal

<u>Materials Australia Silver Medal</u> for outstanding contributions to the advancement of metallurgy and materials science was awarded to Pro-Vice-Chancellor (Research Infrastructure) and DSI member **Professor Simon Ringer** (USYD, postponed from 2020, due to COVID).

The NSW Premier's Prizes for Science and Engineering

This <u>award</u> recognises excellence in science and engineering, and rewards leading researchers for cutting-edge work that has generated economic, environmental, health, social or technological benefits for New South Wales.

- **Associate Professor Chang Xu** (School of Computer Science) NSW Early Career Researcher of the Year.

Faculty of Engineering 2023 SOAR Prize winners

This two-year program will support their research, innovation and professional development.

- **Dr Qiang Tang (CS)** - Early Career Researcher SOAR recipient, Qiang is also the recipient of the 2023 DSI Pilot Project funding
- **Associate Professor Niels Quack** (AMME) - Mid-Career Researcher SOAR recipient

2023 Big Idea

Associate Professor Omid Kavehei received the <u>2023 Big Idea Runner-up Award</u> for BrainConnect, a device to restore the connection between the brain and body and can be used for predicting and preventing epilepsy events.

Recognitions

Australia's Research Leaders

Professor Dacheng Tao (CS) and **Professor Joe Zhu (ECE)** have been named Australia's research field leaders in Computer Vision and Pattern Recognition and Power Engineering respectively in <u>The Australian (print version)</u>.

IEEE Fellowship

The Institute of <u>Electrical and Electronics Engineers (IEEE)</u> is the world's largest trusted voice for engineering, computing and technology information and this award recognises excellence in research and global impact.

- **Professor Salah Sukkarieh** (School of Aerospace, Mechanical and Mechatronic Engineering, <u>Australian Centre for Robotics</u>) and DSI mission lead for the Digital Agriculture.
- **Professor Sri Parameswaran** (School of Electrical and Computing Engineering).

ARC Future Fellows 2023

Associate Professor Dries Verstraete (School of Aerospace, Mechanical and Mechatronic Engineering) – Energy Source Durability for Electric Vertical Take Off and Landing Aircraft
Associate Professor Chang Xu (School of Computer Science) – Deep Adder Networks on Edge Devices

3rd Asia-Pacific International Conference on Additive Manufacturing (APICAM)

Professor Gwenaelle Proust (USyd) co-chaired the highly successful 3rd Asia-Pacific International Conference on Additive Manufacturing (APICAM) co-ordinated by Materials Australia in June 2023.

- She is the 2024 Vice President of Materials Australia!

ARC College of Experts (CoE)

The following DSI members have been elected to the prestigious ARC College of Experts.

- **Professor Gwenaelle Proust** (Civil), Gwenaelle leads the Advanced Manufacturing and Materials Mission of DSI
- **Associate Professor Omid Kavehei** (BME)

Fellow of Engineers Australia

- **Associate Professor Omid Kavehei** (BME) was selected as a Fellow of Engineers Australia (FIEAust).

## Electro Optics Photonics100 2024 List

- **Associate Professor Niels Quack** (AMME) made it to the prestigious Electro Optics Photonics100 2024 list.

Media

- **Associate Professor Omid Kavehei** (BME) was interviewed by <u>SkyNews</u> on the global semiconductor industry and Australia's efforts to boost manufacturing.
- <u>The Urban Developer</u> interviewed **Professor Ian Manchester** on the robotics revolution that is set to disrupt the construction industry.
- **Christina Maher** (BME) wrote an article for <u>The Conversation</u> on the future of brain implants.
- <u>The Australian Financial Review</u> interviewed **Professor Gwenaelle Proust** about research into new technologies for aviation.
- **Dr Qiang Tang** was interviewed by Ricardo Goncalve on SBS on **"The Money Show"** discussing cybersecurity issues
- **Dr Qiang Tang** was also interviewed by ABC News on the <u>Central Bank Digital</u> Currencies and then on the <u>Binance Case</u>(largest cryptocurrency exchange). Qiang is the recipient of the DSI Pilot project
- Have you been fooled by fake texts? <u>Dr Suranga Seneviratne's (CS) article in The Conversation</u> provides insight into this growing and alarming issue.
- **Professor Ian Manchester** the Director of the **Australian Centre for Robotics** was interviewed on <u>Channel 9 News</u>, along with the Centre's industry partners, who gave an overview of the University's robotics research.
- **Associate Professor Niels Quack** (AMME) on the article in <u>Electronics Online</u> and <u>Photonics Online</u> who reported on developing technology to combine optics and micro-electromechanical systems (MEMS) in a microchip.
- <u>The Sydney Morning Herald</u> interviewed **Dr Mahyar Shirvanimoghaddam** about 3G devices requiring maintenance.
- <u>The Australian</u> interviewed **Professor Judy Kay** about the eight grand challenges in dealing with the impact of AI on education.
- **Dr Jonathan Kummerfeld** was interviewed by **6PR** about the potential for AI to interfere with election integrity.
- <u>Sydney Morning Herald</u> published an opinion piece by **Dr Suranga Seneviratne** from the Faculty of Engineering about the **rise of ChatGPT's "evil cousin" WormGPT**
- **Professor Ian Manchester** and **Professor Stefan Williams** were interviewed by Tech Business News on <u>University of Sydney Launches New Robotic Inspection and Asset Management Hub (ARIAM)</u>
- <u>2GB Radio</u> interviewed **Professor David Levinson** on the impact of traffic for the new M4 tunnel at Anzac Bridge.
- <u>Rivers FM</u> interviewed **Professor Salah Sukkarieh** and his team on developing an electric powered two wheeled tractor which can assist smallholder farmers.
- **Professor Nick Lawson** talked to <u>Channel Nine</u> about the state of the art Eight360 Nova Flight Simulator.
- Congratulations to **Dr Josiah Poon** on being awarded USD$60K (about AUD$94K) from the <u>Google Inclusion Research Program</u> for the project "Multimodal Mental Illness Detection and Explanation".
- **Titanic submersible – rapid-response:** Director **Professor Stefan Williams** worked on a <u>The Conversation op-ed</u> for the Titanic submersible which was republished globally, including by Forbes, BBC and ABC (US). It had over 300 direct shares on social media. This resulted in over 1,000 media mentions of Professor Williams' comments between 20-23 June 2023, and over 50 interview requests (around 42* fulfilled) with international and domestic media, including interviews with the Wall Street Journal, CNN, BBC, Agence Presse France, Times Radio UK, Fox News, Reuters, Volant (Iran), Fox News, The Guardian UK, CNA (Singapore), Radio NZ, Scripps News and SBS World News, Forbes, Yahoo News, <u>Channel 7 Sunrise</u>, Cosmos Magazine, **CBC**, ABC Perth Radio and ABC. Fox/Sky named the Titanic submersible story as one of the 5 biggest global stories of 2023.

Professor Williams' expertise is in the field for marine robotics and his research focus is on the development and deployment of autonomous underwater vehicles whose visual and acoustic sensors can gather data for the purpose of generating high-resolution 3D models of underwater marine environments.
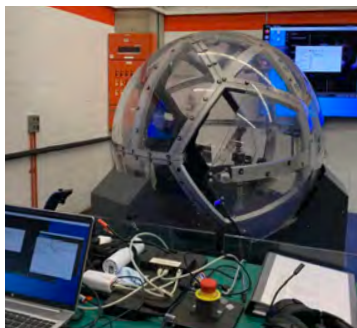
Nova Simulator

Titanic Submersible

Efficient Deep Learning
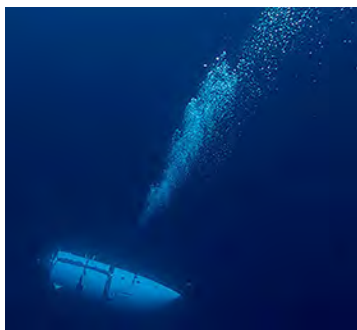
Grant Funding

DSI Led Funding

Vonwiller Foundation

- *Philanthropic donation to support data analytics for Coronary Heart Disease* (CIs:Figtree, Grieves, Kim, Zhou) $1M
- *Precision Agriculture* (CIs: Sukkarieh, McBratney, Bishop) $1M.

Data61 AI and Emerging Technologies

- *Prototype Warfare* (CI: Verstraete, Partners: DSTG, UTS) $1.2M.

Meta – Towards Trustworthy Products in AR, VR, and Smart Devices and Security Research

- *User-centric 3D spatial data sharing in metaverse* (CI: Thilakarathna and Zomaya) $75k USD.

Rio Tinto Aluminium

- *Stochastic Modelling for Bulk Handling in Aluminium Processing* (CI: Einav, Marks, Guillard, Cleary) $1.05M. This project demonstrates a strong collaboration established with the Data Centric group members with the DSI.

Defence Innovation Network (DIN)

- **Professor TJ Lim and Dr Kanchana Thilakarathna:** *Edge AI in Multiple UAVs for ISR and Communications* is a multi-university and industry collaboration led by University of Sydney. The project is investigating distributed machine learning algorithms for deployment in multi-UAV ISR and communication-centric applications that account for physical constraints such as payload, manoeuvrability and energy and minimize probability of detection.
- **A/Prof Craig Jin, Professor Stefan B. Williams and WSU team:** Real-time *Neuromorphic Acoustic Sensing System for Autonomous Systems* was successfully awarded a DIN Pilot Project 2.0.

Other Grant Funding

ARC Linkage projects commenced in 2023

Visual methods for advanced automation of underwater manipulation

- **Professor Stefan Williams** (AMME), **Dr Viorelalla** (AMME), **Associate Professor Tongliang Liu** (CS), **Dr Oscar Pizarro** (ACFR) et al., will partner with Reach Robotics, Woods Hole Oceanographic Institution, Geo Oceans and Norwegian University of Science and Technology to improve the perception and situational awareness of underwater robotic systems.
- *Self-supervised feature learning for rapid processing of marine imagery*
- **Professor Stefan Williams** (AMME), **Associate Professor Tongliang Liu** (CS), **Dr Oscar Pizarro** (ACFR) et al. with GREYBITS ENGINEERING and FATHOM PACIFIC PTY LTD and Norwegian University of Science and Technology to develop self-supervised techniques that use large amounts of unlabeled data of sea floor images to enhance performance of marine environmental health studies.

ARC Discovery Projects 2024

- **Professor Itai Einav** and **Dr Francois Guillard** (both Civil) for A novel granular pressure sensor for geotechnology and ground robotics
- **Professor Fernando Calamante** and **Dr Jinglei Lv** (both BME) for Novel tractography-guided MRI methods for studying healthy brain ageing
- **Professor Dacheng Tao** (CS) for Quantum Generative Diffusion Models for Molecular Research
- **Dr Chang Xu** (CS) for Unsupervised Visual Pre-Training via Extreme Image Denoising
- **Professor Ben Thornber, Professor Ian Manchester** (AMME) and **Professor Gregor Verbic** (ECE) for Harnessing the Power of Wind: Revolutionising Wind Farm Optimisation.
- **Professor Joachim Gudmundsson** and **Dr André van Renssen** (both CS) for Algorithms for Future-Proof Networks
- **Professor Luming Shen, Associate Professor Daniel Dias-da-Costa** (both Civil) for Unlocking self-healing bio-concrete through multiscale modelling.
- **Professor Kalervo Gulson** (FASS) for Artificial intelligence in education: Democratising policy.

ARC Linkage Infrastructure, Equipment and Facilities (LIEF)

- **Professor Gwenaelle Proust** (Civil), **Professor Simon Ringer** (ACMM & AMME), **Professor Anna Paradowska** (Civil), **Dr Xianghai An** (AMME), along with their team will work on a $546,000 project to develop a powder manufacturing facility for Additive Manufacturing

Medical Research Future Fund

- **Dr Ryan Sullivan** (BME/ICT) chief investigator with Prof Rosalind Jeferee's team were awarded $5,990,000 for their project "*Supporting brain cancer research with an integrated network of platforms*" from the MRFF Brain Cancer Infrastructure grant. Will build on AIS to implement a large-scale histological image repository and with integrated AI for training and testing of cutting edge diagnostic systems.
- **Dr Ryan Sullivan** from the Digital Health Imaging group also led a successful MRFF $3M Critical Research Infrastructure grant to expand the Australian Imaging Service (AIS), partnering with the Australian Cancer Research Foundation (ACRF) and the Australian Centre of Excellence in Melanoma Imaging & Diagnosis (ACRF ACEMID). AIS-SHIELDS will implement secure national infrastructure for privacy preserving analysis of sensitive imaging and health data, including Natural Language Processing and Federated Learning platforms. This infrastructure will be available to all University researchers as it is rolled out.

Australia's Economic Accelerator (AEA) Seed Grants

- **Professor Xiaoke Yi** (ECE)'s **AEA success** *"Sensing the unseen: Advanced hydrogen gas sensor".*

Tech Central Funding

- Two projects involving **Professor Fariba Dehghani** and **Associate Professor Craig Jin** from the Faculty of Engineering and Professor Brent Kaiser from the Faculty of Science received $3.6 million in Tech Central funding. **More details**.

Education / training outputs

- **Dr Qiang Tang**, the DSI pilot project recipient developed some relevant privacy preserving cryptocurrency content for COMP5617, which will be further refined and integrated.
- The digital twin (DT) model by Associate Professor **Ali Hadigheh** as part of his pilot project funding served as a teaching resource in the course *'CIVL5277 Structural Rehabilitation and Timber Design,'* benefiting over 60 undergraduate and postgraduate students at USyd. In collaboration with other universities, there are plans to grant access to the use of this Digital Twin (DT) model for students in other universities across the country.

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