

# DRIVING INNOVATION FOR INDUSTRY THROUGH AI



University of  
South Australia

INDUSTRIAL AI  
RESEARCH CENTRE

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THE INDUSTRIAL AI RESEARCH CENTRE IS AT THE LEADING EDGE OF THE GLOBAL REVOLUTION IN ARTIFICIAL INTELLIGENCE, MACHINE LEARNING, INDUSTRY 4.0 AND INTERNET-OF-THINGS (IOT) TECHNOLOGIES.

We bring together a diverse group of experts to develop solutions for autonomous and augmented intelligence systems. We draw on our extensive combined expertise in artificial intelligence, machine learning, software engineering, mathematics, and engineering to solve real-world problems that deliver impactful outcomes.

Partnering with world-class organisations such as BAE, Fequentis and others, we develop intelligent systems that process and understand large amounts of complex data and information. Our AI-driven solutions can be applied across a vast range of disciplines, from health and environment to oil and gas to Defence.



## **#1 IN AUSTRALIA FOR RESEARCH IMPACT AND ENGAGEMENT**

2018 ARC Engagement and Impact Assessment (EI), Combined Impact – Approach to Impact and Engagement on Assessed Fields



## **ABOVE WORLD- CLASS RESEARCH**

Results in 2018 Excellence in Research for Australia (ERA)



## **100% OF OUR ASSESSED RESEARCH RATED AT OR ABOVE WORLD CLASS**

2018 Excellence in Research for Australia (ERA), 4-digit Fields of Research.





## OUR RESEARCH

### WE THRIVE ON INNOVATION AND IMPLEMENTING RESEARCH DRIVEN SOLUTIONS ACROSS A WIDE RANGE OF INDUSTRIES.

Our ability to understand and model complex, interconnected systems is at the core of our capabilities in driving research to build and enhance fundamental new technologies.

Our research expertise embraces the synthesis that spans a broad range of disciplines including artificial intelligence, machine learning, interoperability, ontology engineering, natural language processing, mathematics, statistical modelling and inference, data analytics, signal processing, satellite systems and optimisation.

We create Digital Twins of systems and processes that enable intelligent decision-making, improve information extraction from textual documents and resources and support data fusion and simulation technologies to achieve information superiority.

Our expertise in modelling environmental and health systems has resulted in the development of reliable, real-time forecasting capabilities. Through data analytics and image analysis we enable pattern recognition and detection of anomalous behaviours to develop causal representations of complex systems, and we use visualisation to support contextually-aware decision-making.

Through the Australian OIIE™ Interoperability Laboratory we pilot new business models to support asset intensive industries with our gold standard work in ontology engineering, creating best practices for industrial information exchange.



## OUR IMPACT

**WE FOSTER AN ENTERPRISING CULTURE OF RESEARCH AND COLLABORATION. OUR WORK WITH INDUSTRY, GOVERNMENT AND THE COMMUNITY REDEFINES THE USE OF INDUSTRIAL AI AND INDUSTRY 4.0 AND LEADS THE FUTURE OF ADVANCED TECHNOLOGIES.**

We are proud of our decades-long track record that tells the story of our successful and enduring partnerships. Through our committed focus on translating research into tangible, successful outcomes, we have implemented real-world operational solutions across multiple arenas. Our collaborative partnerships result in strengthening capability, adaptability and competitiveness.

We understand the importance of building fit-for-purpose models to influence and support industry today and into the future. We utilise the unique capabilities across our talented teams to pioneer specially-designed solutions tailored for the needs of each partnership. Our results speak for themselves. They are evident all around us: from the quality of the air we breathe to the water we all drink. They are also found in the vital tasks of shaping defence decision-making and action-taking, in accelerating advances in manufacturing, enhancing satellite resilience and informing leading climate experts. We stand at the forefront of Industrial AI and are committed to continuing our story of ongoing innovation.

### CLEANING UP RADAR SEA CLUTTER

**We're leading the way in strategic defence capabilities and radar innovation.**

In collaboration with REDARC Defence Systems and Raytheon Anschutz GmbH, we are delivering novel and simple optimal waveform diversity techniques for small target detection that can adapt to the environment and overcome sea clutter. Sea clutter, which includes high seas and storms, can make radar detection of objects in the ocean extremely difficult and hinder rescue operations and hazard identification. Our innovation has the potential to significantly increase detection capacity.

Our work in optimising target detection for marine radars is set to advance high performance radar systems for the Navy and Air Force and at the same time could have significant benefits for ocean search and rescue and border security operations. In 2019, the South Australian Defence Innovation Partnership Cooperative Research Grants awarded UniSA \$150,000 to support the project.

This project is just one of many to emerge from our Defence Innovation Partnership, which is designed to generate defence related research and development activity in South Australia between industry, universities and government.





## TRANSFORMING DEFENCE

**We are a key partner in defence research, generating world-leading manufacturing technologies.**

In a partnership delivering world-leading manufacturing technologies to the Hunter Class Frigate Program, Australia's Innovative Manufacturing Cooperative Research Centre (IMCRC), the University of South Australia and BAE Australia's shipbuilding business, ASC Shipbuilding, have made a co-investment worth more than \$4 million in data analytics and AI.

UniSA is spearheading and driving the development of digital manufacturing (Industry 4.0), improving shipyard planning and adding unique data analytics and problem-solving capacity to the Hunter program at Osborne Naval Shipyard, which will deliver nine state-of-the-art anti-submarine frigates to the Royal Australian Navy at the most technologically advanced shipyard in the coming decade.



## EMPLOYMENT INTERVENTIONS BOOST DISABILITY EMPLOYABILITY

**Working with Maxima Group, a not-for-profit Disability Employment Services (DES), a mathematical tool automatically calculates priority skills required by disabled individuals to maximise their employment potential.**

Most disabled jobseekers seek help from DES consultants for advice on which skills they should focus on to improve their employment chances. It's impractical to improve all skills so finding ways to prioritise is important. By inputting DES data extracted from Maxima's business platform, we're able to construct a causal learning model to recommend the best employment interventions.

Our causal recommendation systems are now streamlining the services at Maxima and make it easier for people with a disability. Improving employability and employment processes for jobseekers with a disability is always beneficial and bring us one step closer to being a more inclusive and responsive society.



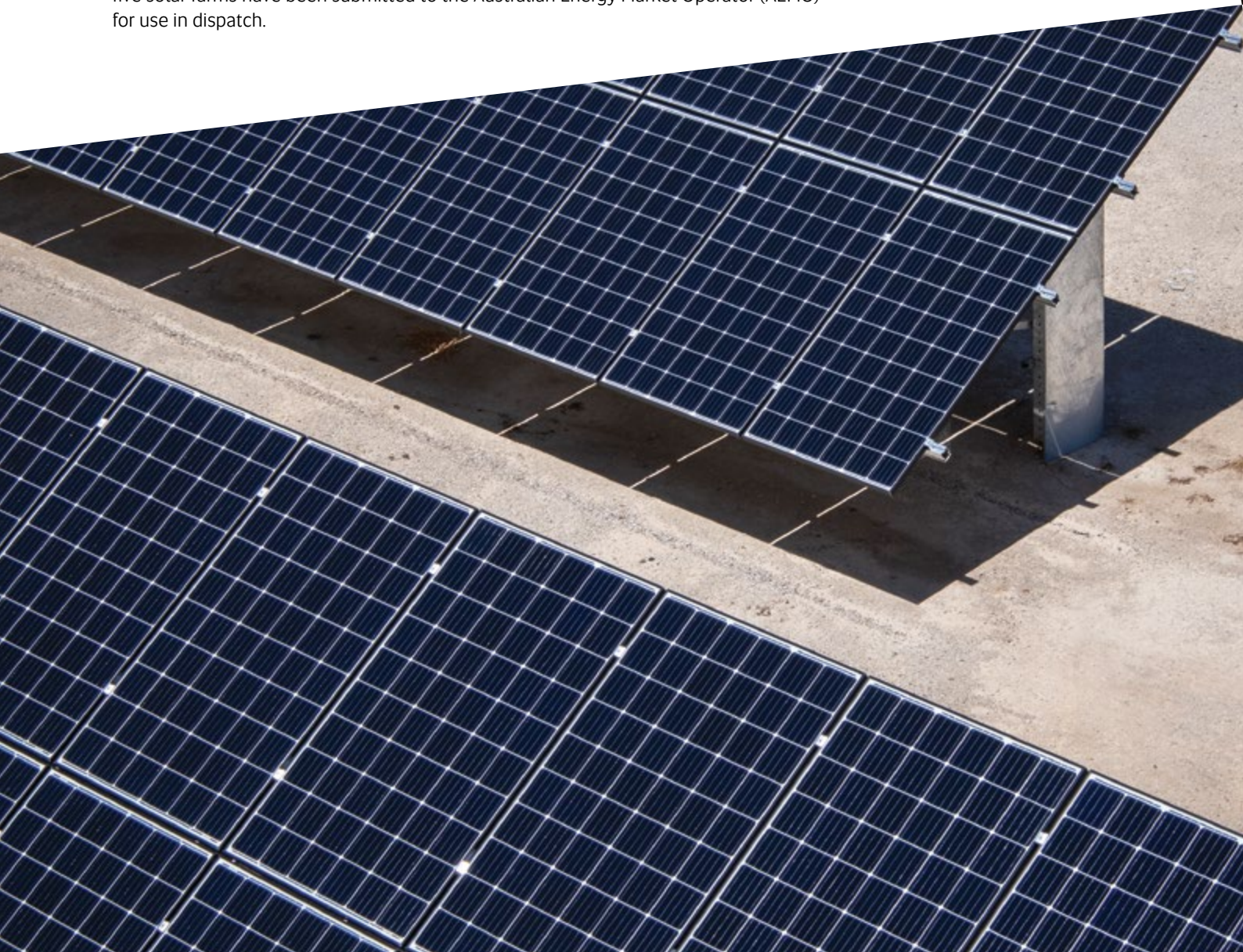
## SKYCAM AND MULTI-MODEL SOLAR FORECASTING

OUR WORLD CLASS FORECASTING RESEARCH AND TECHNOLOGY IS INFORMING THE WORLD'S CLIMATE EXPERTS.

In partnership with Industrial Monitoring & Control (IMC), CSIRO and the University of New South Wales, we set out to improve the accuracy of solar forecasting by increasing grid stability and security, helping to better integrate renewable sources into the National Energy Market (NEM).

The project trialled market participant five-minute self-forecast (MP5F) technology at a geographically and operationally diverse set of NEM-connected solar farms. Fourteen real-time solar power forecasting models were developed, deployed and continuously improved on five solar farms over nine months. Individual models forecasts were combined into ensemble models, improving the overall prediction accuracy.

Our high-performing ensemble of models is now producing live forecasts used in real time energy market dispatch and is generating large fee reductions for the participating solar generators, helping to enable a more stable grid with higher renewable energy penetration, lower energy prices and ultimately lower carbon emissions. MP5F for the five solar farms have been submitted to the Australian Energy Market Operator (AEMO) for use in dispatch.







## FROM TEXT TO SIMULATION ENVIRONMENTS

### OUR EXPERTISE IN NATURAL LANGUAGE PROCESSING AND NOVEL MODELLING TECHNIQUES IS CHANGING HOW DEFENCE ACT.

Partnering with the Defence Science and Technology Group, we have developed representations of individual, squad, and larger group behaviour for combat simulations. Our researchers are helping improve reuse and consistency across simulation software packages and improve the development time of complex behaviours, allowing faster turnaround on developing and testing scenarios.

The project leverages Natural Language Processing/Understanding technologies to analyse doctrinal texts into first-cut graphical models. These models use a generic behaviour notation to capture essential elements of behaviours independent of the simulation environment; the modelling tools allow the refinement of simple models into complex behaviours. Finally, models are transformed into executable code which allows behaviours to be executed in target simulation environments.

The project has delivered high-impact outcomes for Defence. Our technology allows Defence to quickly develop simulation behaviours and reuse across simulation environments to rapidly test alternative scenarios, improve doctrine, and evaluate new equipment and tactics.







## **AI FOR DEFENCE INTELLIGENCE**

### **OUR COLLABORATIVE EFFORTS WITH DEFENCE ARE HELPING KEEP AUSTRALIA SAFE, PROVIDING CYBER ANALYSTS WITH NOVEL INSIGHTS USING ARTIFICIAL INTELLIGENCE.**

In an important collaboration with the Defence and Science Technology Group, University of Wollongong, The University of Adelaide, and Data61, we are jointly developing artificial intelligence technologies that help cyber intelligence analysts understand computer networks and analyse potential attacks in situations where little information about the networks is available.

The process gathers and reconciles incomplete and uncertain information about the network, identifies potential plans for attacks on the network, and monitors the progress of activities. Our researchers create novel automated techniques to devise analysts' goals into actionable plans, probe networks to gather information, and distill key insights from uncertain and incomplete information.

The project develops technologies to refine goals into detailed plans that interleave information gathering with exploiting vulnerabilities in the network, artificial intelligence methods to reconcile uncertain information about the network into a coherent view, and software architectures for enacting the planned activities and capturing the progress of goals.

## **OUR CO-DEVELOPED DRIVER ADVICE SYSTEM IS NOW ON-BOARD MORE THAN 8,000 TRAINS WORLDWIDE**

**THE TTG ENERGYSER TECHNOLOGY HAS HAD A PROFOUND AND LONG-LASTING IMPACT ON ENERGY EFFICIENCY WORLD-WIDE.**

At the forefront of innovation, in partnership with Trapeze Rail, we have devised a train driver advice system called TTG Energysiser. The system continually calculates the most efficient way to complete a journey, accounting for track gradients, speed and power limits, and advises the driver when to apply power, maintain speed, coast and brake, all whilst reconciling against the timetable.

This pioneering system generates proven significant energy, CO2 and cost reductions and has consequently been adopted worldwide. It is now in use on more than 8,000 trains across the UK, Spain, France, Mauritania, Australia and New Zealand.

The highly successful collaboration has delivered far-reaching impact that will continue to benefit the transport industry well into the future. TTG Energysiser has earned multiple awards, including an Australian Export Award, NSW Premier's Export Award and Australian Rail Industry Award, and put the TTG on track for global growth.

## **"THE AMOUNT WE'VE SAVED IN FUEL AND DOLLAR TERMS HAS BEEN A REVELATION"**

**- PETER REIDY, CEO, KIWI RAIL**









## DELIVERING THE INDUSTRY 4.0 REVOLUTION

THE AUSTRALIAN OIIE™ INTEROPERABILITY LABORATORY PILOTS NEW BUSINESS MODELS TO SUPPORT ASSET INTENSIVE INDUSTRIES AND MEET THE INCREASING DEMANDS FOR SOPHISTICATED INTERNET COMMUNICATION TECHNOLOGIES AND DATA ANALYTICS.

By shifting information and operational technology systems from ad-hoc bespoke implementations to a standards-based model, the Australian OIIE™ Laboratory delivers analytics that enable software and service providers to focus on their value-add proposition.

Partnering with industry we enable enterprises to investigate the integration of OIIE technologies into their digital organisational frameworks. We partner with key researchers to leverage the Laboratory's new technologies in partnership with other participating organisations.

Our Laboratory will be affiliated with the OIIE Australian Working Group, which aims to promote industry interoperability and engage with Australian SMEs to provide unique services to projects. As part of its involvement with the Future Energy Exports Cooperative Research Centre (FEnEx CRC), the Laboratory will provide cross-project infrastructure and capability for the FEnEx CRC to deliver its research programme.

The Laboratory also supports the OIIE OGI Pilot, to produce a platform for Australian participants to engage internationally with industry.







## PARTNERING FOR SUCCESS

**We have an outstanding track record of successfully combining our research expertise and facilities in unique and custom ways that meet our partners' needs. We invite you to explore opportunities to collaborate with us.**

### LEVERAGE OUR EXPERTS

Talk with us about a variety of industry engagement and partnership options that are designed to help your organisation stay ahead of the competition. We welcome you to take advantage of our world-leading researchers whose knowledge of current and emerging technologies offer valuable insights into product development roadmaps. Collaborate with us on research and development projects that aim to solve challenging technical problems and create leading new products and services that can be commercialised.

### HOST NEW TALENT

Consider harnessing the expertise of a research degree student. Develop a research project in collaboration with UniSA and you can gain a fresh perspective on your project or business needs. Collaborating on a custom project will provide your organisation with the advantage of accessing and integrating up to the minute research knowledge in current and emerging technologies.

### DISCOVER THE RIGHT PARTNERSHIP FOR YOUR ORGANISATION

Our partnerships come in many forms including collaborative research, contract research, consultancy, strategic partnerships, sponsoring PhDs and student projects. Talk to us about a variety of industry engagement and partnership options that are designed to help your organisation stay ahead of the competition.

Our research capabilities are vast and our passion for problem-solving runs deep. A sample of our research expertise is provided here, however we encourage you to uncover a richer exploration of the UniSA Industrial AI Research Centre.

**For more information or to partner with us please email [IndustrialAI@unisa.edu.au](mailto:IndustrialAI@unisa.edu.au)**

### SOME OF OUR PARTNERS

The logo for BAE SYSTEMS, featuring the text "BAE SYSTEMS" in white capital letters on a red rectangular background.The logo for DST GROUP, with "DST" in a large, bold, black sans-serif font above the word "GROUP" in a smaller, black sans-serif font.The logo for Lockheed Martin Australia, featuring the text "LOCKHEED MARTIN" in a blue sans-serif font above a stylized blue starburst graphic, with the word "Australia" in a smaller font below.The logo for Raytheon Anschutz, consisting of a red sunburst icon to the left of the text "Raytheon" in a bold, black sans-serif font, with "Anschutz" in a smaller, black sans-serif font below it.The logo for REDARC DEFENCE SYSTEMS, with "REDARC" in white capital letters on a red rectangular background, and "DEFENCE SYSTEMS" in a smaller, black sans-serif font below.The logo for synengco, featuring a green and blue circular graphic to the left of the text "synengco" in a lowercase, blue sans-serif font.The logo for MIMOSA, with the word "MIMOSA" in white capital letters on a green rectangular background with a diagonal line pattern.The logo for NERA NATIONAL ENERGY RESOURCES AUSTRALIA, with "NERA" in a large, bold, blue sans-serif font, and "NATIONAL ENERGY RESOURCES AUSTRALIA" in a smaller, black sans-serif font below.



# GLOBAL LEADERS

Our people are world leaders in artificial intelligence.



**PROFESSOR MARKUS STUMPTNER**  
DIRECTOR

**Professor Markus is the Director of UniSA Industrial AI and also the Program Lead for Digital Technologies and Interoperability in the Future Energy Exports CRC.**

His research area sits at the junction of different computing disciplines across artificial intelligence, software engineering, data and process management.

His underlying goal is to develop high efficiency methods for modelling and constructing intelligent software systems that solve real-world problems, typically from an industrial and organisational background.

The main focus of his most recent work is in the areas of Industry 4.0, interoperability, integration, Self-Aware Systems and autonomous decision-making, complex event processing, software system evolution and debugging, and emergent semantics. Typical application areas involve the autonomous enterprise, intelligent asset management/plant operations, future aware business processes, ontologies for design and product configuration, and health and bioinformatics.



**PROFESSOR JOHN BOLAND**  
DEPUTY DIRECTOR

**Professor John Boland is a Deputy Director at the UniSA Industrial AI Research Centre and a Fellow of the Modelling and Simulation Society of Australia and New Zealand, and of the Australian Institute of Energy.**

His research covers a wide range of areas in environmental mathematics, from water resource management to renewable energy utilisation to the mathematical and statistical analysis of energy efficient house design to environmental accounting.

One of the tools he and his team has constructed, the Boland-Ridley-Lauret diffuse radiation model, is used by the Bureau of Meteorology to construct gridded solar data for the whole of Australia, and thus is used for the evaluation of solar projects throughout the country. It is also used in the Meteornorm software for similar work throughout the world. His work on short term solar forecasting has resulted in his being part of the International Energy Agency Task 16 on Solar resource assessment for high penetration and large-scale photovoltaic applications, in conjunction with the foremost experts in the field.



**ASSOCIATE PROFESSOR BELINDA CHIERA**  
DEPUTY DIRECTOR

**Associate Professor Belinda Chiera is a Deputy Director of the UniSA Industrial AI Research Centre and adjunct faculty at Johns Hopkins University (Zanvyl Krieger School of Arts & Sciences, Advanced Academics Programs).**

Her expertise spans a wide range of interests and applications in highly complex real-world systems. Her research focuses predominantly on the themes of pattern recognition, anomaly detection, early warning systems, network modelling, contextual visualisation and data-driven decision-making. She is motivated by inventive problem-solving to develop custom models and tools that combine established theory with the latest advances in modelling and data analytics of real-world systems.

Translation of her research is found in environmental applications including monitoring of air quality affected by vehicle and industrial pollutants, counterintelligence operations to combat terrorism, social network and social media analysis, resource management across distributed high-dimensional networks, hospital treatment programs and the Australian Football League.



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South Australia

## INDUSTRIAL AI RESEARCH CENTRE

[Unisa.edu.au/Industrial-AI](https://unisa.edu.au/Industrial-AI)

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#### Acknowledgement of Country

UnISA respects the Kurna, Boandik and Bangarla peoples spiritual relationship with their country.

Artist: Ngupulya Pumani

Find out more about the University's commitment to reconciliation at [unisa.edu.au/RAP](https://unisa.edu.au/RAP)

**Australia's University of Enterprise**