



THE UNIVERSITY  
of ADELAIDE



# ADELAIDE SUMMER RESEARCH SCHOLARSHIPS (ASRS) PROGRAM

ECMS PROJECT CATALOG 2020-21

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# Schools

## SABE

### School of Architecture and Built Environment

**Project title:** Building Faith in Multicultural Australia

**Research theme(s):** Sustainable and Smart Built Environments

**Project description:** Sustainable, resilient communities are grounded in knowledge of and respect for cultural difference. Focusing on architecture, this project contributes to new knowledge about the place of migrant communities in Australia with emphasis on South Asian migration after 1970. Students will gain research training in archival research and academic writing as they compile a database which records diverse architectural projects including community facilities, places of faith, houses or educational spaces. Inspired by the Australian Islamic Centre designed by Pritzker-prize winner Glenn Murcutt with Hakan Elevli, the goal of this project is to generate new knowledge about migrant communities in Australia and to build faith (literally and metaphorically) in multicultural Australia. The Centre for Asian and Middle Eastern Architecture (CAMEA) is offering four summer research scholarships to contribute to this project and the selected students will be based in the archive room at the School of Architecture and Built Environment.

**Project supervisor(s):** Please contact [Dr Katharine Bartsch](#) and [Associate Professor Peter Scriver](#) for further information.

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**Project title:** Databases for Building Information Modelling-supported Green Building Assessment

**Research theme(s):** Sustainable and Smart Built Environments

**Project description:** The potential of using Building Information Modelling (BIM) in the digitalisation of green building assessment schemes (GBAS) has received increasing attention in both academia and industry. The key in BIM-based GBAS is the data flow. The data can be either quantitative or qualitative, from various sources such as the designers and manufacturers, and generated by different BIM applications, to serve different GBAS criteria. This project explores the application of augmented (building element library of BIM applications), external and functional databases to integrate data required for GBAS. Students need to review the use of BIM in GBAS briefly and choose to conduct one, two or all of the following three research activities, namely identifying variances in the structure of augmented and external databases in BIM applications, exploring the creation of sustainable manufacturer-certified product information databases, and investigating the use of functional databases for qualitative data storage and retrieval for BIM-based GBAS.

**Project supervisor(s):** Please contact [Dr Ruidong Chang](#) or [Professor Jian Zuo](#) for further information.

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**Project title:** A 5D Building Information Modelling-based construction and demolition waste information management system

**Research theme(s):** Sustainable and Smart Built Environments

**Project description:** Construction and demolition waste (CDW), as a major source of solid waste, needs to be systemically managed, including the estimation of CDW generation, the sorting and treatment of CDW, and the impact assessments of CDW. CDW also leads to other environmental impacts, such as the generation of greenhouse gas (GHG) emissions during the disposal of CDW, which also needs to be systemically managed. This project aims to use 5D building information modelling as a technical foundation to explore the development of an

information management system to quantify CDW generation, the economic loss of CDW landfill, and the generation of GHG emissions of CDW disposal. Students will use one BIM application such as Revit, one 5D BIM software application such as CostX, and identify mathematical equations of GHG emission quantifications to streamline the process of 5D BIM-based CDW management.

**Project supervisor(s):** Please contact [Professor Jian Zuo](#) or [Dr Ruidong Chang](#) for further information.

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**Project title:** Post-pandemic design, construction and operation of built environment

**Research theme(s):** Sustainable and Smart Built Environments

**Project description:** Covid-19 pandemic has presented significant challenges to the current practices of operating the built environment. Office buildings is one of sectors that have been affected significantly. With the priority on the health and wellbeing of building users, the economic performance presents another significant challenge. There have been a large number of discussions around the world on the changes required. The reconfiguration of HVAC system, for example, is one of recommendations made by some professional associations.

The successful candidate will assist the supervisors to analyze the current practices on office building operation in the wake of Covid-19 pandemic. Attention will be paid on the discrepancies between practices and policies across states and cities, as well as recommendations made by various professional associations. Common practices will be identified whereas the challenges will be highlighted. These provide useful inputs for the future endeavor of office building design, construction and operation.

**Project supervisor(s):** Please contact [Professor Jian Zuo](#) or [Dr Ruidong Chang](#) for further information.

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**Project title:** Cooling capacity of urban green(ery)

**Research theme(s):** Sustainable and Smart Built Environments

**Project description:** This pilot study will map the surface and air temperature reduction capacity of 10 urban vegetation types including 3 types of large trees, 2 types of medium trees and 2 types of small trees, Shrubs and turf in the City of Adelaide. It is part of an ongoing project at the School of Architecture and Built Environment. Initial data will be available by Dec 2019 and this project will collect extended summer data. There is a considerable research on cooling effect of urban greenery in large scales but when it comes to smaller scales and the trade-offs between required water, maintenance and cooling effect of urban vegetation, there is very limited resources.

The successful applicant will assist data collection from sample plant species, thermal photography and ambient-radiant temperature recording during summer 2019-20. The applicant may be involved in data analysed via i-Tree and ENVI-met for a journal paper in 2020.

**Project supervisor(s):** Please contact [Dr Ehsan Sharifi](#) for further information.

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**Project title:** Are you too cold or too hot? Investigating the impact of design on the indoor environment quality of a hospital ward

**Research theme(s):** Sustainable and Smart Built Environments; Health and Biotechnology

**Project description:** Indoor environmental quality (IEQ) has been shown to have impact on people's health and well-being. This relationship is even more crucial in a healing environment, such as a hospital ward. This research will investigate the indoor environment quality of the geriatric ward in The Queen Elizabeth Hospital through both quantitative method (measurements/monitoring of indoor temperatures, humidity, air movement, noise and light levels) and qualitative method (interview with patients and/or family members and staff). The relationship between IEQ and the design of the building will also be investigated. The results will help inform the building facility management on how to improve the IEQ of the ward as well as provide some evidence-based

guideline to building designers.

**Project supervisor(s):** Please contact [Professor Veronica Soebarto](#) and [Professor Renuka Visvanathan](#) for further information.

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**Project title:** Lunar Habitat Architecture

**Research theme(s):** Sustainable and Smart Built Environments; Defence, Cyber and Space

**Project description:** The Lunar Habitat Architecture project sets up an opportunity for students to work on the exciting proposition of designing a human habitation on the Moon. The project extends from the establishment of the Australian Space Agency in South Australia and the growing interest in turning short-term expeditions into longer-term settlements. Here at the University, the School of Architecture is working with the newly established Centre for Sustainable Planetary and Space Resources (CSPSR) and other colleagues in Engineering to develop a sustainable, self-sufficient space exploration and settlement program. Students will form part of a growing student network for Space Architecture and serve as research assistants in ongoing publications and laboratory based research work related to this topic. The focus of research can range from technical material behaviour, to structural systems, construction techniques, and management of space construction, to the psycho-social considerations of space habitation as explored through its architecture.

**Project supervisor(s):** Please contact [Dr Amit Srivastava](#) for further information.

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# ASPER

## Australian School of Petroleum and Energy Resources

**Project title:** Fixing reservoir fines to prevent formation damage in oil/gas wells: *Laboratory Visualisation study*

**Research theme(s):** Energy, Mining and Resources

**Project description:** We develop a technology to fix reservoir fines during oil and gas production, in order to prevent and mitigate the induced formation damage. The key point is to treat well with some solute and promote attraction particle-rock. The work includes flow tests with colloidal-suspension fluids, observations under the microscope, filming, and analysing the results. The project also encompasses evaluation of electrostatic forces and detachment management by salinity alteration. This project is continuation of 2014-2018 honours projects supported by Santos (SA) and Wintershall (Germany).

**Project supervisor(s):** Please contact [Dr Abbas Zeinijahromi](#), [Dr Themis Carageorgos](#) or [Prof Pavel Bedrikovetsky](#) for further information. Also supervising this project will be Thom Russell and Lara Chequer (PhD candidates) and Engineer Mark Burgoyne (Santos).

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**Project title:** Environmental control of coal seam gas production

**Research theme(s):** Energy, Mining and Resources

**Project description:** Production of fines, i.e. coal particles during dewatering of coal seam gas (CSG) reservoirs, is one of drastic environmental concerns in Australia and worldwide. Therefore, prevention, mitigation, and prediction of the coal fines production is one of the milestones of effective gas production from CSG's. The modern theory of fines detachment, migration and consequent formation damage has been developed at ASP during 2008-2019 and applied in numerous projects on oil and gas recovery. The present project continuous this sequence of fines migration honours projects, but with applications to CSG reservoirs. The students with mechanical, chemical, and civil engineering background with strong interest in scientific engineering are encouraged to apply.

This project is continuation of 2012-2018 honours projects supported by Santos (SA).

**Project supervisor(s):** Please contact [Prof Pavel Bedrikovetsky](#) or [Dr Themis Carageorgos](#) for further information. Also supervising this project will be Abolfazl Hashemi (PhD candidate) and engineer Mark Burgoyne (Santos Ltd).

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**Project title:** Visualisation of fines migration in two-phase environment

**Research theme(s):** Energy, Mining and Resources

**Project description:** Several environmental studies on fines propagation in aquifers have shown that low salinity water in the reservoir rocks can cause reduction of rock permeability. The phenomenon is explained by mobilization of reservoir fines which plug the narrow pore constrictions. The main forces acting on a particle on the surface of a pore are drag, lift, gravity and electrostatic forces. The mechanical equilibrium of an attached particle is determined by torque balance of these four major forces. Drag and lift forces increase with increasing flow velocity and act to detach the particle from the pore wall. The total electrostatic force describes the interaction or contact of a particle and pore wall at very small separations and is largely dependent on changes to water composition. The total electrostatic force is taken as the maximum value of the sum of the Van der Waals, electrical double layer and Born forces as described by Derjaguin, Landau, Verwey and Overbeek (DLVO) theory. The total attractive electrostatic force decreases as the water salinity decreases causing the particles dislodgment by the low salinity water flow.

In this project a transparent flow cell is placed on a high resolution microscope to observe the effect of water composition on fines attachment and detachment. Several tests with varying water composition will be performed to visualise fines mobilisation at different conditions. The torque balance theory then will be applied to compare with the experimental results.

**Project supervisors(s):** Please contact [Dr Abbas Zeinijahromi](#), [Prof Pavel Bedrikovetsky](#) or [Dr Themis Carageorgos](#) for further information.

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**Project title:** Novel retention phenomena at fluid filtering in rocks (with applications to environmental engineering)

**Research theme(s):** Energy, Mining and Resources

**Project description:** In 2018, two Honours students along with supervisors, performed averaging of micro-scale equations for colloidal transport in rock, carried out modelling using the macro-scale model, and predicted non-monotonic retention profiles, which was clearly confirmed by lab experiments. Currently we are finalising the paper for Nature. The reservoir production applications include: I -particle sizing in injected water; II - using formation damage for enhanced waterflood sweep, and III - development of lab method to determine pore size distribution.

The project encompasses mathematical modelling using the derived filtering equations, comparison with experimental results, and applications to three above mentioned technologies. The students with mechanical, chemical, and civil engineering background with strong interest in scientific engineering are encouraged to apply.

**Project supervisor(s):** Please contact [Prof P Bedrikovetsky](#) for further information. Also supervising this project will be Gabriel Malgaresi (PhD candidate) and engineer Mark Burgoyne (Santos).

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**Project title:** Enhanced Low-Salinity Waterflooding in Copper and Eromanga Basins: *Laboratory Modelling*

**Research theme(s):** Energy, Mining and Resources

**Project description:** Presently under the low and uncertain oil-prices environment, the Low-Salinity Waterflooding is considered as one of the most cost-effective methods of EOR. In 2012-2018 ASP proposed a novel technology of FINES-ASSISTED LOW-SALINITY WATERFLOOD.

The project aims the Laboratory Modelling of this technology, i.e. of the flow of oil and waters with different salinity in artificial rocks with different clay contents. Numerous corefloods will be performed with measurements of flow rates of water and oil, pressure drop in three points and fines concentrations in the effluent. Lab coreflood data will be compared with CMG Stars simulation.

This project is continuation of 2017 and 2018 honours projects supported by Santos (SA) and Wintershall (Germany). The project goes far beyond the lab methods given in the PetrEng course "Formation Damage and Productivity Enhancement".

**Project supervisor(s):** Please contact [Dr Abbas Zeinijahromi](#), [Prof Pavel Bedrikovetsky](#) or [Dr Alex Badalyan](#) for further information. Also supervising this project will be engineer Mark Burgoyne (Santos).

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**Project title:** Enhanced Low-Salinity Waterflooding in Copper and Eromanga Basins: *Mathematical Modelling and Reservoir Simulation*

**Research theme(s):** Energy, Mining and Resources

**Project description:** Presently under the low and uncertain oil-prices environment, the Low-Salinity Waterflooding is considered as one of the most cost-effective methods of EOR. In 2012-2018 ASP proposed a novel technology of FINES-ASSISTED LOW-SALINITY WATERFLOOD.

The project aims the Mathematical Modelling and Reservoir Simulation of this technology, i.e. of the flow of oil and waters with different salinity in heterogeneous reservoirs with different clay contents. CMG Stars will perform the reservoir simulation. The laboratory data will be used as an input into reservoir simulator.

This project is continuation of 2016 and 2017 honours projects supported by Santos (SA) and Wintershall (Germany). The project goes far beyond the reservoir simulation methods given in the PetrEng course “Formation Damage and Productivity Enhancement”.

**Project supervisor(s):** Please contact [Prof Pavel Bedrikovetsky](#) or [Dr Abbas Zeinijahromi](#) for further information. Also supervising this project will be engineer Mark Burgoyne (Santos).

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**Project title:** Particle sizing in drilling fluid to minimise formation damage and filtrate losses

**Research theme(s):** Energy, Mining and Resources

**Project description:** Invasion of drilling fluid damaging reservoir takes place in drilling and completion of oil wells. The permeability damage is caused by capture of solid particles by the rock from invaded fluid. External filter cake also results in decreased return permeability. Correct choice of particle size distribution in the fluid would minimise particle invasion and consequent formation damage providing minimum losses of filtrate into formation during drilling.

Presently the design of injected fluid is performed experimentally. It is well known that tests on drilling fluid filtration and corefloods by injected water are complex and cumbersome, very time consuming. It puts significant constrain on number of tests necessary to optimise the fluid design. The limited number of tests is performed during drilling or injection in any oilfield.

This project uses recently developed mathematical model of particle penetration into porous media to design drilling/injection fluid. The project aims the development of a simple procedure of damage estimation and consequent fluid design to be used during drilling.

The project involves extensive modelling using Excel or MathLab.

**Project supervisor(s):** Please contact [Prof Pavel Bedrikovetsky](#) or [Dr Alex Badalyan](#) for further information.

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# CEAM

## School of Chemical Engineering and Advanced Materials

**Project title:** Atmospheric pressure cold plasma treatment of potatoes

**Research theme(s):** Agrifood and Wine

**Project description:** Black dot disease, caused by the fungus *Colletotrichum coccodes*, has become an economically problem in potato. It is characterized by silvery lesions on the tuber surface, resulting in a deterioration in skin quality. Also, the black dot causes symptoms on stems and foliage, making crop losses and is implicated as a factor in the potato early dying disease complex. The ability to generate low temperature plasma offers new opportunities to decontaminate biological materials, including fresh foods.

In this study, potatoes will be treated with two kinds of cold plasma generators, the KINPEN and DIENER surface treatment machines. Previous studies reported that atmospheric plasma can cure fungus-infected plant and provide a novel biotechnological approach to disease resistance. Reactive radicals generated in the plasma jet can pass through microns-sized and have strong oxidative effects on the pathogen cells of plant. It is expected the same effect could be achieved on potato.

**Project supervisor(s):** Please contact [Professor Volker Hessel](#) or [Dr Nam Tran](#) for further information.

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**Project title:** KINPEN Microplasma Jet-based Synthesis of N-doped Carbon Dots for Agricultural Applications

**Research theme(s):** Functional Materials

**Project description:** Purpose: the aim of this study is to synthesize new material used N-doped CDs from folic acid for agricultural applications as a fertilizer.

Introduction: Over the past few decades, abundant nanomaterials have been developed and applied in agriculture to monitor crop health, promote the growth of crops, improve the efficiency of fertilizer and pesticides, and manage diseases, pests, and environmental stresses. In recent years, CDs have been the focal point of interest for many researchers in agricultural applications, since they have superior and universal properties such as easy functionalization with biomolecules and chemical inertness. Therefore, in this project, a new microplasma method has been used to synthesize N-doped CDs for agricultural applications.

Task and outcomes: Students will synthesize N-doped CDs using KINPEN microplasma jet and characterize the materials.

**Project supervisor(s):** Please contact [Professor Volker Hessel](#) or [Hue Pho](#) for further information.

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**Project title:** Continuous solvent extraction of adjacent metals in a coiled micro-flow inverter for asteroid ores

**Research theme(s):** Energy, Mining & Resources, Advanced Manufacturing

**Project description:** Asteroid mining has been proposed as an approach to complement Earth-based supplies of rare earth metals and supplying resources in space, such as water. In this study, process schemes will be developed for two resources: metallic asteroids, such as (6178)1086 DA (89% Fe, 10% Ni, Co/Pt traces; value 35 trillion dollars), and mineral asteroids (chondrites/olivinepyroxene with up to 50% metal). The experimental study will be conducted to test how continuous flow processing can cope with outer space mining conditions. Real asteroid ores will be tested both at lab-scale with a coiled micro-flow inverter using segmented flow, and at pilot-scale with the Corning reactor. Computational solvent modelling will be applied to select the best solvent for the separation of products. Importantly, the study will also aim at minimising the use of water in space mining.

**Project supervisor(s):** Please contact [Professor Volker Hessel](#) or [Dr Nam Tran](#) for further information.

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**Project title:** Continuous-flow phosphate leaching from mimicked moon crust

**Research theme(s):** Energy, Mining & Resources, Advanced Manufacturing

**Project description:** Phosphorous, while not an expensive element, is of great importance due to its requirement to sustain life. The earth will run out of phosphorus in about 50 years. There are a large number of phosphate extraction at hand, and most of those seem to be suited for continuous-flow implementation. Yet, current methods of terrestrial phosphate extraction on earth involve the use of acids which while cheap here on earth but would require expensive supply chain in space and adds hazards as concentrated acids are corrosive. The proposed project will apply segmented micro-flow extraction and separation of phosphorus using a micro-scale coiled flow inverter (CFI) and a re-entrance reactor. The aimed outcome is a higher extraction efficiency by the internal circulation flow generated within slugs as well as a fast processing time, keeping the overall ISRU equipment module at small footprint.

**Project supervisor(s):** Please contact [Professor Volker Hessel](#) or [Dr Nam Tran](#) for further information.

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**Project title:** Modelling carbon materials for clean energy conversion reactions by computational chemistry

**Research theme(s):** Functional Materials; Energy, Resources and Environment

**Project description:** The dwindling supply of fossil fuels urges us to explore alternative power sources to drive our highly automotive society. Under this background, establish reliable, clean and sustainable energy supplies are of great importance, and using electrochemical methods to realize energy conversions hold a great promise. Among these reactions, hydrogen evolution reaction (HER), oxygen reduction reaction (ORR), and CO<sub>2</sub> reduction reaction (CRR) are the most studied, due to their respective roles in hydrogen production, fuel cells, and fuel generation, respectively. Effective candidates for these reactions are often based on metals, while the potential of carbon-based electrocatalysts for these reactions is not fully discovered.

This project will investigate the potential of carbon based materials - which are cheap, abundant, and easy to modify - for these reactions by computational chemistry approach.

**Project supervisor(s):** Please contact [Dr Yan Jiao](#) for further information.

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**Project title:** Development of novel nanoporous photonic crystals for lab-on-a-chip biosensing applications

**Research theme(s):** Functional Materials; Health and Biotechnology

**Project description:** In this project, we will aim to develop a synthesis approach to fabricate nanoporous photonic crystal structures for optical biosensing applications. Photonic crystal structures will be fabricated by electrochemical oxidation of aluminium. The resulting structures will be assessed for lab-on-a-chip applications.

**Project supervisor(s):** Please contact [Dr Abel Santos](#) for further information.

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**Project title:** Development of nanoporous photocatalysts for environmental remediation applications

**Research theme(s):** Functional Materials; Energy, Resources and Environment

**Project description:** In this project, we will aim to develop nanoporous materials for photocatalysis applications. Photonic crystal structures will be fabricated by electrochemical oxidation of aluminium.

The resulting structures will be assessed for light-driven degradation of environmental pollutants and toxicants.

**Project supervisor(s):** Please contact [Dr Abel Santos](#) or [Cheryl Suwen Law](#) for further information.

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**Project title:** Micro-scale anaerobic digestion of food waste

**Research theme(s):** Energy, Mining and Resources; Agrifood and Wine

**Project description:** The food industry sectors currently incur a cost for disposing of food wastes. Ideally, any “waste” product from these industries becomes a feedstock for another product and market. This project proposes a research that will result in a circular economy through the production of biogas from food waste via anaerobic digestion. Anaerobic digestion is a biological process in which microorganisms break down organic matters in the absence of oxygen. Biogas, which is the one the end products, consists of ~60-70% of methane (CH<sub>4</sub>) and the rest is carbon dioxide (CO<sub>2</sub>) with a trace of hydrogen sulphide (H<sub>2</sub>S), can be used as a natural gas replacement for heat and power generation. The slurry, the other end produce, can be further processed and utilised as a compost or fertiliser. This research project of food waste to biogas will be demonstrated by the end of the project.

**Project supervisor(s):** Please contact [Dr Woei Saw](#) for further information.

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**Project title:** Designing brewing and distillation systems for beverage engineering research purposes

**Research theme(s):** Agrifood and Wine

**Project description:** In this project the participant will design a series of systems for Brewing and Distillation to be used for research into Beverage Engineering. Depending on the outcomes of the design, commissioning of the systems may be undertaken.

**Project supervisor(s):** Please contact [Dr Philip van Eyk](#) for further information.

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**Project title:** Nanostructured Electrocatalysts for On-Site/Demand Hydrogen Peroxide Production

**Research theme(s):** Health and Biotechnology; Functional Materials

**Project description:** Hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>) is one of the most important industrial chemicals as an environmentally friendly oxidant for various applications. Direct electrochemical reduction of O<sub>2</sub> to H<sub>2</sub>O<sub>2</sub> via two-electron pathway provides an attractive alternative to the energy- and waste-intensive industrial anthraquinone process.

In this project, novel nanostructured electrocatalysts will be developed to improve the performance for electrocatalytic H<sub>2</sub>O<sub>2</sub> production with selectivity higher than 80% in acid and higher than 90% in neutral; obtained materials will then be integrated into a prototype reactor for the stable production of H<sub>2</sub>O<sub>2</sub> with a concentration above 3 wt% toward direct application in disinfection and water treatment.

Success in such research has major implications and benefits for the fundamental research and technology innovations in sustainable energy, clean water, and chemical industries in Australia and globally.

**Project supervisor(s):** Please contact [Professor Shizhang Qiao](#) or [Dr Cheng Tang](#) for further information.

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**Project title:** Production of agricultural residues pellets: Art or Science?

**Research theme(s):** Agrifood and Wine; Advanced Manufacturing

**Project description:** Agricultural residue typically has very low density of 50-150kg/m<sup>3</sup>, which could be a high cost penalty to transport to a central plant for energy utilisation. Pelletisation is a densification process that can reduce cost of transportation due to the increase of its density by 4-8 depending on the operating condition. However, pelletisation of agricultural residues can be challenging. Therefore, the aim of this study is to assess pelletisation conditions for various agricultural residues to generate quality pellets for various application.

**Project supervisor(s):** Please contact [Dr Woei Saw](#) or [Dr Gule Li](#) for further information.

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**Project title:** Inverse modelling for climate impact assessment of the Kangaroo Island water supply system

**Research theme(s):** Energy, Mining and Resources

**Project description:** The performance of water resources and environmental systems are affected by changes in hydro-climatic variables. These systems may be vulnerable to changes in multiple statistical attributes of the variables. For example, reservoir operation could be influenced by changes in total precipitation, changes in the intensity of extreme rainfall, or the changes in water demand-driven evapotranspiration or temperature. Inverse modelling involves the generation of stochastic time series with targeted changes in hydro-climatic attributes that would enable the assessment of system performance under a range of conditions.

This project is part of ongoing development and application of research tools to model changes in the attributes of hydro-climatic time series. The project will be done in collaboration with the industry to apply inverse modelling to study the climate impacts on a real-world water supply system in Kangaroo Island.

**Project supervisor(s):** Please contact [Professor Seth Westra](#) or [Dr Anjana Devanand](#) for further information.

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**Project title:** Impact of agricultural intensification on temperature extremes

**Research theme(s):** Energy, Mining and Resources; Agrifood and Wine

**Project description:** Agricultural practices change land surface characteristics and influence the regional climate. In some areas, these regional influences are strong enough to nullify or even reverse the global warming signal. The use of specific cultivation practices to mitigate near-surface warming is also being discussed as a potential climate change mitigation option.

This project will use Earth system model experiments to examine the impact of the historical expansion of agriculture on regional temperature extremes. The outcomes of the project would help guide decisions around future land management strategies. The work will involve the analysis and visualization of large datasets from climate model simulations and the use of statistical techniques to identify key signals in the data. Thus this project presents a unique opportunity to work with big datasets and gain transferrable data analysis skills that can be applied to multiple fields.

**Project supervisor(s):** Please contact [Dr Anjana Devanand](#) or [Professor Seth Westra](#) for further information.

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**Project title:** Flexibly-assembled and durable structures for modular and automatic construction of future civil infrastructures

**Research theme(s):** Energy, Mining and Resources; Advanced Manufacturing

**Project description:** Construction of civil infrastructures, such as buildings and bridges, is one of the largest contributors to greenhouse gas emission, energy consumption and waste generation, resulting in economical and environmental sacrifices. Modular or automatic construction technology initiated in recent years enables to save the energy and costs and reduce environmental impacts and construction periods. However, the application of modular construction requires light-weight and durable structures which can be flexibly manufactured and assembled in factories for structural modules and onsite for module assembly to form buildings and bridges.



The overarching aim of this project is to develop the structural members for modular construction so that the barriers for its wider applications can be effectively overcome. Advanced construction materials will be used and the performance of optimised structural members for modular construction will be evaluated through numerical modelling.

**Project supervisor(s):** Please contact [Dr Han Fang](#) or [Associate Professor Phillip Visintin](#) for further information.

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**Project title:** Developing green and fire resistant structures for houses and apartments in Australia

**Research theme(s):** Sustainable and Smart Built Environments; Functional Materials

**Project description:** Houses and apartments in Australia are increasingly demanded with the growth of population and receive the investment of billions of dollars per year in Australia. The construction of houses and apartments is one industry sector that consumes considerable material and resources, generates significant waste and noise and causes high greenhouse gas emission. Besides, the severe damages of houses and subsequent loss of life due to bush-fire in Australia leads to the urgent need to develop fire resistant structures for future houses and apartments.

Therefore, this project aims to achieve the dual aims by using green materials and developing structures with improved fire resistance. The fire-resistant performance reflected by the coupled thermal-mechanical properties of the structures will be investigated through finite element analysis and key parameters influencing their fire resistance will be identified for optimising the design for fire resistance.

**Project supervisor(s):** Please contact [Dr Han Fang](#) for further information.

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**Project title:** Benchmarking algorithms for resource management optimization under uncertainty

**Research theme(s):** Energy, Mining and Resources

**Project description:** Modelling practitioners are presently lacking a tool that can be used to optimize resource management strategies in complex environmental settings, and that has the following desirable features: non-intrusiveness (i.e., it can be integrated with any model); computational efficiency; scalability to high dimensions; robustness (i.e., it can account for model uncertainty). We are currently addressing this gap by developing an ensemble-based SQP algorithm.

We are seeking a student with a zest for programming, engineering and mathematics to test this algorithm on large-scale engineering benchmark problems (e.g., Brugge petroleum reservoir).

Other parallel efforts that may also form a focus of the project include implementation of Bayesian inference algorithms (e.g., MCMC, ABC) and a robust MILP algorithm.

This project will be carried out in collaboration with the below-listed supervisor, other developers around the world, and optimization experts at UofA. We would welcome the student to co-author journal articles on these algorithms.

**Project supervisor(s):** Please contact [Dr Matthew Knowling](#) for further information.

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**Project title:** Embedding domain knowledge in machine learning for decision support: A viticulture example

**Research theme(s):** Energy, Mining and Resources; Agrifood and Wine

**Project description:** Machine learning and data-driven approaches more generally are increasingly being applied for the purposes of forecasting and decision support. The applicability of these approaches to problem cases beyond the space spanned by the training data can however be

limited. As such, it is common to train machine learning models not only on the relationship between observation data, but also on the relationships between relevant physical variables simulated using a process-based model (i.e., “meta-modelling” or “emulation”). This project will focus on identifying effective means to embed viticulture domain knowledge (e.g., expressed stochastically via process-based biophysical models) into machine learning models such as LSTMs.

We are seeking an enthusiastic student with experience in machine learning and environmental modelling and engineering. This project will be carried out in close collaboration with the supervisors listed below. It is expected that the successful applicant will be involved in a journal article arising from this work.

**Project supervisor(s):** Please contact [Dr Ehsan Abbasnejad](#) or [Dr Matthew Knowing](#) for further information.

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**Project title:** Vibration analysis of structures

**Research theme(s):** Sustainable and Smart Built Environments

**Project description:** Vibration tests provide a practical way to determine dynamic properties of structures using vibration data. Modal identification allows extraction of important information for evaluating the structural performance and serviceability of a wide range of civil and building structures, such as suspension bridges, tall buildings, footbridges and stadiums etc. It provides information about the ‘in-situ’ vibration properties of constructed structures, which can differ significantly from the design. Discrepancies in the order of 30% in predicting the vibration frequency of structures are not uncommon. The project will focus on vibration testing of structures using measured vibration data.

**Project supervisor(s):** Please contact [Assoc Professor Alex \(Ching Tai\) Ng](#) for further information.

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**Project title:** Nonlinear ultrasonic guided wave for next generation non-destructive evaluation and safety inspection

**Research theme(s):** Sustainable and Smart Built Environments; Energy, Mining and Resources

**Project description:** Ultrasonic guided wave has been widely recognised as one of the promising non-destructive evaluation (NDE) and safety inspection technologies for a wide range of engineering structures. It has been used in different engineering industries, such as civil structures, buildings, aerospace, oil pipelines, and land and water transport infrastructure.

This project will explore the nonlinear features of ultrasonic guided waves for early stage identification of defects in structures. This can significantly improve the detection limit compared to conventional NED technologies and provide conditional-based maintenance, resulting in significant cost savings in maintenance.

**Project supervisor(s):** Please contact [Assoc Professor Alex \(Ching Tai\) Ng](#) for further information.

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**Project title:** How Brittle is high strength steels?

**Research theme(s):** Sustainable and Smart Built Environments

**Project description:** This project will use Digital Image Correlation (DIC) technique in conjunction with standard experiments for the determination of both essential and non-essential works of fracture of high strength structural steels supplied by BlueScope. A series of experiments have been conducted and data available for post-failure analysis to obtain full field strains and their evolutions during deformation. The analysis of experimental data using DIC will help obtain both essential and non-essential works of fracture to determine how brittleness/ductility of the steels.

**Project supervisor(s):** Please contact [Dr Giang Nguyen](#) for further information.

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**Project title:** Resilient structural panels for energy efficient building

**Research theme(s):** Sustainable and Smart Built Environments

**Project description:** The structural insulated panels are made of a lightweight thick layer of polymer foam as core insulation layer sandwiched between two face sheets made of thin layers of strong materials. The popularity of these panels has been increasing steadily in many structural applications including building walls, floors and roofs. Apart from energy saving in cooling and heating, these panels help to reduce the cost of supporting members such as beams, columns and foundations. The construction cost and time is also reduced due to their prefabricated form and all these lead to reduction of the lifetime cost of buildings. As the existing panels do not have adequate resistance against strength, fire, impact, and other actions due to inferior face sheets, hybrid face sheets made of concrete and FRP layers has recently been conceptualized at Adelaide. You are expected to work and improve the design these panels.

**Project supervisor(s):** Please contact [Dr Abdul HAMID Sheikh](#) for further information.

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**Project title:** Long terms response of ultrahigh performance concrete structures

**Research theme(s):** Sustainable and Smart Built Environments

**Project description:** Ultra high performance concrete (UHPC) is a relatively new material which has a huge potential of its application in various civil engineering structures. The material exhibits a very high compressive strength that is about 4 to 8 times of the normal concrete strength. The use of steel fibres in the concrete mix helps to improve the ductility by enhancing the tensile failure strain due to fibre bridging. The durability of the material is also very high due to its dense formation. All these superior features help to achieve a thinner/slender UHPC member design, which is extremely useful in long span structures such as bridges. The long term behaviour of these bridge structures due to creep is an important problem that has drawn significant attentions after the collapse of a bridge in US. You will work on this structural problem to gain a better understanding its behavior.

**Project supervisor(s):** Please contact [Dr Abdul HAMID Sheikh](#) for further information.

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**Project title:** A cost-effective environmentally-friendly approach for soil stabilization

**Research theme(s):** Functional Materials; Advanced Manufacturing; Energy, Mining and Resources

**Project description:** We often face different geotechnical problems in fine graded soils. One of the problems is the non-uniform settlement of roadway or building foundation. This can result from soft spots in the clay, insufficient compaction of foundation materials, and consolidation of subsoil caused by building or traffic loads and also by soil subsidence due to groundwater extraction. Therefore, a suitable ground improvement technique is needed for geotechnical engineering projects in order to confront these problems. Chemical stabilisation through traditional cementitious agents including cement, lime and fly-ash can be regarded among the most common solutions in this context.

Application of polymers as a chemical stabilisation method has recently received attention as well. In this project, new additives will be used to develop a soil suitable for different engineering applications.

In this study application of different soil stabilisation methods will be investigated.

**Project supervisor(s):** Please contact [Dr Abbas Taheri](#) for further information.

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**Project title:** Development of a Model to Predict the Strength of Rocks

**Research theme(s):** Energy, Mining and Resources

**Project description:** Extensive experimental results on different rock material are available for this project. The student will use the existing results to develop a model that can predict the peak strength of rock material from the deformability properties. The model will be useful to predict the strength of rocks without breaking the sample in compression. Excel and/or MATLAB will be used to analyse the results.

**Project supervisor(s):** Please contact [Dr Abbas Taheri](#) for further information.

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**Project title:** Assessing the environmental impact of concrete in construction

**Research theme(s):** Functional Materials; Advanced Manufacturing; Energy, Mining and Resources

**Project description:** The standard of living offered by modern society is infeasible without the use of the cement based materials upon which the construction of all forms of structures and infrastructure is based. Evidence of this can be seen by examining the usage of cement in the past 65 years, which shows cement production has increased 3400% while the population has only grown 300%. Cement is now the highest volume manufactured product, with an annual consumption of 4.6 billion tonnes, equating to more than 600kg/capita – a number higher than food consumption.

In addition to the high production volume, concrete manufacture is the third highest emitter of CO<sub>2</sub> behind energy production and transport. Significant international research effort is therefore being devoted to the development of greener concretes.

This project will assess a range of green concrete alternatives using detailed life cycle analysis to identify the optimal usage of concrete materials in structures.

**Project supervisor(s):** Please contact [Associate Professor Phillip Visintin](#) for more information.

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**Project title:** Developing design approaches for ultra-high performance fibre reinforced concrete

**Research theme(s):** Sustainable and Smart Built Environments; Advanced Manufacturing

**Project description:** The design of reinforced concrete members is commonly controlled by limits on member deflection and crack width. Despite this importance, the determination of member deflection and crack width is highly dependent on the application of empirically derived factors that correct for the differences between the mechanics of design approaches that are based on full-interaction and real world measurement that is based on partial-interaction. This problem is particularly important when considering realistic loading combinations involving time dependent deformations and high cycle fatigue. In this project we will seek to develop improved design approaches for new ultra-high performance concretes by redefining correction factors based on mechanics solutions.

**Project supervisor(s):** Please contact [Associate Professor Phillip Visintin](#) for more information.

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# COMP SCI

## School of Computer Science

**Project title:** Evolutionary Diversity Optimisation

**Research theme(s):** Energy, Mining and Resources; Advanced Manufacturing

**Project description:** Diversity optimisation is beneficial to many industrial application areas as it provides a large variety of high quality and innovative design choices. Diversity can drive innovation and deliver promising results in complex problems and optimisation. You will design and analyse algorithms for computing a diverse set of solutions that all meet given quality criteria, and explore the impact of different diversity strategies. A background on algorithms and programming knowledge is beneficial. The project is suitable for a student interested both in a career in research or in industry.

**Project supervisor(s):** Please contact [Prof Frank Neumann](#) or [Dr Aneta Neumann](#) or for further information.

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**Project title:** Artificial Intelligence - Innovative approaches for increasing the productivity of South Australia's copper and gold production

**Research theme(s):** Energy, Mining and Resources

**Project description:** Artificial Intelligence is currently used in various ways to solve significant industry challenges. You will develop advanced technologies to help boost South Australia's copper and gold production. The topic spans from experimental investigations of algorithms to data analysis using machine learning methods. The project can be carried out dependent on the background and interest of the students. The project is suitable for a student interested both in a career in research or in industry.

**Project supervisor(s):** Please contact [Prof Frank Neumann](#) or [Dr Aneta Neumann](#) or for further information.

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**Project title:** Advanced Ore Mine Optimisation under Uncertainty

**Research theme(s):** Energy, Mining and Resources

**Project description:** Mining processes involve a lot of uncertainties due to the lack of information about ore grades within the ore body. Using an average model or an average gold/copper price leads to weakness/limitation of models that does not take into account the effect of potentially large losses due to deviations from the expected value. In order to improve the estimate of a mining projects value you will model the uncertainty and establish confidence intervals for optimised solutions. The topic spans from experimental investigations of algorithms for ore grade estimation and optimisation of mine design and scheduling to data analysis based on machine learning (e.g. deep neural networks). The project is suitable for a student interested both in a career in research or in industry.

**Project supervisor(s):** Please contact [Prof Frank Neumann](#) or [Dr Aneta Neumann](#) or for further information.

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**Project title:** Applying a Deep-Learned Surrogate Function for the Evolution of a 3D Geological Map of Australia

**Research theme(s):** Energy, Mining and Resources

**Project description:** The Aim of this project is use deep learning to create a function that will greatly speed up the production of a high-quality 3D geological map of Australia.

**Background:** As the world becomes increasingly resource-constrained, improving our knowledge of the Earth's geology is becoming vital. Many geological mapping techniques map the earth by refining a series of guesses until we achieve a map that matches collected sensor data. Unfortunately this process is currently constrained by having a slow process assessing guesses.

**Project:** In this work we improve on previous work by learning a function using 3D convolutional nets to represent maps of the deep earth and generating an artificial response from these maps. These responses will then be integrated into an existing search framework to produce 3D maps within minutes, rather than weeks. It expected that this work will greatly speed up the production of detailed geological maps of Australia.

**Project supervisor(s):** Please contact [Dr Brad Alexander](#) for further information.

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**Project title:** Exploring the application of deep learning to assessment of code style

**Project description:** Coding style impacts on the maintainability and extensibility of software systems as well as the likelihood of errors. Assessing code style is, however, a time-consuming task. In programming courses, as in industry, code style is most commonly assessed through manual code review. This approach limits the amount of feedback that can be provided to students who are developing code style and to system developers to improve their software. Tools such as linters are able to assess adherence to various style guidelines but still are unable to identify deeper features of code style or to learn new patterns from examples or counter examples. In this project you will work alongside researchers in deep learning, software engineering and computer science education\* to investigate the use of deep learning to improve the assessment of style beyond linter applications, compare to human assessment and identify current limitations.

**Project supervisor(s):** Please contact [Dr Cheryl Pope](#) or [Dr Brad Alexander](#) for further information. Also supervising this project will be [Dr Christoph Treude](#), [Dr Markus Wagner](#) and [Dr Cruz Izu](#).

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**Project title:** Machine Learning for Detecting Data Exfiltration Attacks

**Research theme(s):** Defence, Cyber and Space

**Project description:** Data exfiltration is the process of retrieving, copying, and/or transferring data without authorization. In 2018, 53,000 data exfiltration incidents have been reported. The primary reason of these incidents is the inability to detect attacks in real-time. This project aims to utilize big data technologies (e.g., Hadoop and Spark) for developing a cyber security system that can accurately detect data exfiltration attacks at real-time. The project will be developed using our big data infrastructure consisting of private clouds, containers technologies, and Microsoft Azure. The project will leverage Data Mining, Machine Learning (ML), and Natural Processing Language (NLP) for detecting cyber security attacks using data exfiltration datasets.

**Project supervisor(s):** Please contact [Professor M. Ali Babar](#) and [Dr Faheem Ullah](#) for further information.

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**Project title: Designing Optimised Machine Learning Solutions for Security Analytics**

**Project theme(s):** Defence, Cyber and Space

**Project description:** Big Data Cybersecurity Analytics (BDCA) systems use big data frameworks (e.g., Hadoop and Spark) for analysing security event data to detect cyber-attacks. The available big data frameworks use different Machine Learning (ML) algorithms for optimising cybersecurity analytical solutions. It is important to implement and understand the Machine Learning (ML) algorithms and optimisation mechanisms underpinning the well-known big data frameworks like Hadoop and Spark. This project will compare the performance of big data frameworks while using different ML algorithms and optimisation in terms of response time for processing big security data. The project will also implement a set of algorithms for optimising solutions for security analytics.

**Project supervisor(s):** Please contact [Professor M. Ali Babar](#) and [Dr Faheem Ullah](#) for further information.

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**Project title: Blockchain for Electronic Medical Records**

**Project theme(s):** Health and Biotechnology

**Project description:** Electronic Medical Records (EMR) contain patient and population health information which are stored electronically in a digital format. They help to improve quality care for patients. EMR are generated independently by different health providers following each incident, hence, there is a need to exchange and synchronise these records to capture the state of a patient across time. This project explores the use of Blockchain (Ethereum or Hyperledger) and Smart Contracts to exchange and synchronise EMR across health providers. A student is expected to develop a blockchain based decentralised system which allows multiple health providers to access and modify a synchronised set of EMR.

**Project supervisor(s):** Please contact [Professor M. Ali Babar](#) and [Nguyen Khoi Tran](#) for further information.

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**Project title: Common Operating Picture for Blockchain Applications**

**Project description:** Blockchain applications, also known as Distributed Apps (DApps) are software systems whose data and operation logics are maintained by a blockchain network instead of a single entity. Due to the prohibitive costs associated with blockchain storage and updates, DApps maintain only their core data and logic on-chain and distribute the rest of the data across multiple cloud services, clients, and even private blockchain networks. This project aims to develop a Web-based utility to visualise the internal states and activities of all components constituting a DApp. A student is expected to work with an existing blockchain-based smart home system to enhance its capabilities for gathering and visualising the states and activities involved in a blockchain system.

**Project supervisor(s):** Please contact [Professor M. Ali Babar](#) and [Nguyen Khoi Tran](#) for further information.

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**Project title: Blockchain for Smart Home**

**Project theme(s):** Sustainable and Smart Built Environments

**Project description:** Privacy of personal data collected by devices and longevity of their services are major concerns in developing smart homes. The current paradigm which relies on cloud services to operate smart home devices has not been able to address the privacy and trustworthiness problems when the services are dependent upon manufacturers. A potential solution is to remove the reliance on manufacturers by distributing data and control of smart home devices across a blockchain network. This project is built upon an existing blockchain-based smart home system. A student is expected to design and develop optimization mechanisms to reduce the response time and operational cost incurred by the existing system.

**Project supervisor(s):** Please contact [Professor M. Ali Babar](#) and [Nguyen Khoi Tran](#) for further information.

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**Project title:** AL/ML models for understating operating environment

**Project theme(s):** Defence, Cyber and Space

**Project description:** Identifying objects in an environment and establishing their relationship with each other as well as to the environment is of critical importance for autonomous robots. This project aims at identifying artificial intelligence and machine learning methods that can be used to identify different types of object which are important related to a mission, and how relationship between the objects can be established. For example, in collaborative TurtleBots, identification of friendly and unfriendly robots and how their movements impact operations of the mission is to be investigated. Another example is identification and movements of the obstacles and their impact on a specific mission.

In addition, identified AI/ML models need to be modified so that they can leverage principles of incremental learning and deployment during the mission.

**Project supervisor(s):** Please contact [Professor M. Ali Babar](#) and [Dr Afeef Chauhan](#) for further information.

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**Project title:** Natural Language Processing for Interpreting Cloud Pain Points

**Project theme(s):** Defence, Cyber and Space

**Project description:** Cloud computing, which enables the delivery of services via the internet, has gained tremendous popularity over the last decade. However, developing cloud applications offers its own set of challenges. As a result, cloud developers turn towards online Q&A forums (e.g., Stack Overflow) to search, post, and discuss cloud computing issues. This project aims to investigate what cloud developers discuss on Q&A websites. The project will use state-of-the-art web crawlers, data cleaning tools, and naturally language processing techniques to understand the cloud topics/issues and their popularity and difficulty. The findings of this project will serve as a guide for cloud developers, educators, and cloud providers to understand technological trends and topics' complexity.

**Project supervisor(s):** Please contact [Professor M. Ali Babar](#) and [Dr Faheem Ullah](#) for further information.

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**Project title:** Distributed autonomous system platform

**Project theme(s):** Defence, Cyber and Space

**Project description:** Distributed autonomous systems consist of several participating entities that perform together to achieve a specific mission objective. While performing in a collaborative manner, the distributed autonomous systems not only need to consider what aspects of the operations are assigned to different entities, but also require making desired data and processing algorithms on those devices that can be used to perform the operations. This project aims at investigating different tasks and data distribution methodology, as well as performing operations on distributed autonomous nodes securely, reliability and in an autonomic manner. This project target domain involving autonomous land based and air born vehicles.

**Project supervisor(s):** Please contact [Professor M. Ali Babar](#) and [Dr Faheem Ullah](#) for further information.

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**Project title: Wild animal identification from acoustic recording: a deep learning solution**

**Project theme(s):** Health and Biotechnology

**Project description:** Identifying wild animals from acoustic sensory data is an attractive technology for environmental monitoring and wild animal preservation. For example, with this technology, we can build devices that can estimate the population of certain species of wild animals. In this project, you will build a deep neural network for analyzing the acoustic recording of wild animals.

What you will do in this project:

- Learn basic knowledge about deep learning and general machine learning
- Build a deep neural network for acoustic signal processing under our guidance.
- 3. Learn how to use labeled and unlabeled data for training neural networks (some of those techniques are cutting-edge and are recently developed).

Benefits for you:

- Great opportunity in learning machine learning from a practical project.
- Under the supervision of our experienced researcher.
- Master some cutting-edge technologies in machine learning.
- Chance to publish a paper

**Project supervisor(s):** Please contact [Dr Lingqiao Liu](#) for further information.

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**Project title: Collaboration during Group Projects: Reporting on Gender Bias**

**Project description:** Communication plays an important role in the success of group software projects. Communication can contribute to the effectiveness of a team, or could cause an imbalance in group members' tasks, participation, responsibilities, and knowledge sharing. An imbalance might be the result of conscious or unconscious bias within the group dynamic. For example, gender bias might result in women contributing less to the collaboration process. This project looks at the communication conducted between students while working on a group projects, and objectively report on gender bias during the collaboration process. This project uses gender-bias's GitHub project that analyses and summarises language for gender bias to examine group communication within online environments, such as Slack. This project can be the basis for a larger project that identifies strategies to minimise gender bias or provides recommendations for effective group collaboration.

**Project supervisor(s):** Please contact [Dr Rita Garcia](#) for further information.

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**Project title: Detecting Public Sentiment for Australia Property Market from Online Discussion Forum**

**Project theme(s):** Sustainable and Smart Built Environments

**Project description:** Sentiment Analysis (SA) is an important task in natural language processing (NLP). It involves collecting, analysing and summarizing sentiments from different corpus. Online forum is such a corpus that contain rich information from public. In this project, student will work on one popular Australian forum and analyse the discussions regarding Australian housing market. Student will apply the state-of-the-art SA techniques to detect sentiments from the public and predict the impact on future housing prices. Through this project, student will learn Natural Language Processing (NLP) skills on and sentiment analysis, but not limited to.  
Pre-requisites: Python, PyTorch.

**Project supervisor(s):** Please contact [Dr Wei Zhang](#) for further information.

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**Project title:** Fit for purpose 3D mesh modelling

**Project theme(s):** Advanced Manufacturing

**Project description:** The main aim of this project is to explore ways to represent 3D data as a mesh that can be used in applications such as animation and 3D printing. These applications have specific needs in terms of point placement and connectivity that are not satisfied by a general mesh representation, and must be taken into account when preparing an input model. The project requires some background in programming (C or Python) and linear algebra (matrix representations of points, lines, and transformations).

**Project supervisor(s):** Please contact [Dr Anthony Dick](#) for further information.

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# EEE

## School of Electrical and Electronic Engineering

**Project title:** Behavioural analysis of mobile network traffic

**Research theme(s):** Defence, Cyber and Space

**Project description:** The last two decades have marked a dramatic shift to the universal adoption of mobile devices and internet traffic. Mobile devices now account for over half of all time spent online. This time is largely spent using mobile applications (more commonly referred to as apps). From games to online banking, apps have made their way into almost every market. Their ubiquity however has also made the mobile devices they run on a prime target for user analytics and malicious attack.

The aim of this project is to examine what information can be inferred about a mobile device and its applications through analysis of its network communications traffic.

In this project, the students shall:

- Gain knowledge in network traffic analysis
- Generate datasets using an in-house mobile device testbed
- Create novel mobile devices and applications classification systems
- Develop mobile apps for the testbed.

**Project supervisor(s):** Please contact [Dr Hong Gunn Chew](#) or [Dr Adriel Cheng](#) for further information.

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**Project title:** 3D Interferometric Inverse Synthetic Radar

**Research theme(s):** Defence, Cyber and Space

**Project description:** Inverse Synthetic Aperture Radars (ISAR) offer an all-day all-weather capability to form detailed images of targets. Its operating principle relies on the target's own motion to form the synthetic aperture. With targets usually being uncooperative, the images formed with ISAR are projected to an unknown plane, thus making it difficult to interpret the image. A recent approach to overcome this problem exploits phase differences between multiple receivers to determine the target's motion and fully reconstruct the target in three dimensions. Unfortunately, this approach is infeasible for some radar applications due to space and hardware limitations. In this project, you will explore a signal processing based method using a single receiver to perform 3D ISAR reconstruction. The performance of this method is compared against the multiple receiver technique using Matlab simulations.

**Project supervisor(s):** Please contact [Associate Professor Brian Ng](#) for further information.

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**Project title:** Learning dictionaries for radar signals

**Research theme(s):** Defence, Cyber and Space

**Project description:** Dictionary learning is a very flexible technique for a range of signal processing problems. A well-trained dictionary will lead to sparse representations for a class of signals, leading to representation efficiency. Successful examples of dictionary learning include signal denoising, image compression and classification. Most of these successes are obtained with real-valued signals. Radars, in common with telecommunication signals, often use IQ-sampling, resulting in complex-valued baseband signals. In this project, you will explore adapting existing dictionary learning methods for radar target detection. The focus will be on learning dictionaries of potential

target returns to improve target detection performance in the maritime radar environment. The goal is to implement and compare different dictionary learning methods in Matlab.

**Project supervisor(s):** Please contact [Associate Professor Brian Ng](#) for further information.

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**Project title:** Probabilistic forecasting of energy prices in the National Electricity Market (NEM)

**Research theme(s):** Energy, Mining and Resources

**Project description:** The landscape of the power system operation drastically changed since the restructuring of the industry and national electricity market establishment in 1998. These changes have been exacerbated in recent years by introducing intermittent renewable resources (such as wind and PV farms) into the grid. As a result, price volatility is more than ever. In this situation, planning to enter/leave the market and how to bid in the market became a difficult task that needs advanced decision-making tools to predict not only the most probable scenarios but also the risks involved.

In this project, we want to develop a probabilistic forecasting algorithm for energy prices in the NEM considering some external factors/predictors. This project provides an opportunity to learn about electricity market and NEM operation, times series analysis and probabilistic prediction algorithms, data science and programming in Python/MATLAB, and collaborate/write a research paper/report on the study.

**Project supervisor(s):** Please contact [Dr Ali Pourmousavi Kani](#) for further information.

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**Project title:** Consensus Problem in Multi-agent Systems with Heterogeneous Platforms

**Research theme(s):** Defence, Cyber and Space

**Project description:** In practical applications, autonomous and robotic systems use different unmanned vehicles as their body platforms, and different platforms are capable of operating under different environmental conditions. Some of them, like quadruped robots, can be driven in all terrains, and some others can operate under extreme conditions which are originally too dangerous or limited for human access. Multiple different platforms can cooperate in the same multi-agent system to achieve more advanced functions and optimised performances. In recent years, consensus problems in distributed cooperative control of multi-agent systems has become an active topic in the field of automation, and consensus problem of heterogeneous systems, in particular, is a relatively new research topic.

We are introducing a summer research project to develop a distributed cooperative multi-agent system and research on solutions to its consensus problem while loaded in multiple physical platforms. The platforms include Crazyfile mini drones and 3WD rover platforms. Students will be working in our newly renovated autonomous lab which has been equipped with state-of-art equipment and tools.

**Project supervisor(s):** Please contact [Professor Peng Shi](#) or [Vernon \(Xin\) Yuan](#) for further information.

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**Project title: Non-invasive sensing of in-barrel wine fermentation**

**Research theme(s):** Agrifood and Wine

**Project description:** The terahertz range spans 0.1 and 10 THz. It defines a transition between the electronics and photonics domains - the frequency range is at the upper bound of electronics and the lower bound of photonics. Terahertz waves yield an exciting capability of non-destructive evaluation (NDE), since they can penetrate dry and non-metallic materials such as woods. Thus, the capability can benefit quality control of various consumer products. In this project, the student will conduct feasibility study on terahertz non-invasive sensing of wine fermentation in barrel. They will learn skills in advanced signal processing and terahertz measurement.

For more information about the group, see <https://www.thz-el.org/>

**Project supervisor(s):** Please contact [Dr Withawat Withayachumnankul](#) or [Dr Wendy Lee](#) for further information.

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**Project title: Analysing health data from wearables**

**Research theme(s):** Health and Biotechnology

**Project description:** Wearables have become very popular for monitoring exercise and sleep, but their ability to diagnose medical conditions remains largely untested. The aim of the project is to develop data processing algorithms and apply them to large volumes of clinical data to demonstrate their significance. The student will have the opportunity learn about state-of-the-art biomedical signal processing techniques and contribute to an international team of investigators.

**Project supervisor(s):** Please contact [Associate Professor Mathias Baumert](#) for further information.

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# MATHS

## School of Mathematical Sciences

**Project title:** (Mis)information theory, influence, and emotional contagion on social media

**Research theme(s):** Defence, Cyber and Space

**Project description:** The "infodemic" of coordinated misinformation campaigns on social media in recent years is a concern for governments worldwide. Underlying such campaigns are concepts like social networks, information theory (the study of how information flows over networks), and sentiment analysis (the study of emotions in text, which can be used to monitor "emotional contagion"). Projects will look at how these tools can be applied to studying sociotechnical phenomena on social media like Twitter and Reddit, and teach some Python coding + data science skills along the way.

**Project supervisor(s):** Please contact [Dr Lewis Mitchell](#) further information.

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**Project title:** 3D printing for biofabrication

**Research theme(s):** Health and Biotechnology

**Project description:** Biofabrication uses 3D printing to create artificial biological tissues (bone, cartilage, tendons) ... this might sound familiar from the TV show "Westworld"! A new printing technique has been developed that involves melted polymers being stretched into fine threads via the application of an electric field ("melt electrospinning writing"). This project will model the fluid mechanics of thread formation/collection (which can be very complicated, [watch here](#)).

Assumed knowledge: some differential equations, a bit of MATLAB.

**Project supervisor(s):** Please contact [Dr Mike Chen](#) for further information.

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**Project title:** Fixing sore knees: mechanics of artificial cartilage

**Research theme(s):** Health and Biotechnology

**Project description:** Artificial cartilage implants are a proposed alternative to current treatments for osteoarthritis, which involves full joint (knee/hip) replacements and can require extensive rehabilitation. These implants are made by seeding harvested cartilage cells in a gel, then culturing them to produce a mechanically strong implant that can withstand the high stress environment of a joint. This project will model the process of how these cells secrete various interacting substances, which in turn reshapes their surrounding environment into an artificial material that performs like real cartilage.

Assumed knowledge: some differential equations, a bit of MATLAB.

**Project supervisor(s):** Please contact [Dr Mike Chen](#) for further information.

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# MECH ENG

## School of Mechanical Engineering

**Project title:** Extending the life of aircraft structures

**Research theme(s):** Defence, Cyber and Space

**Project description:** The two most critical threats to structural integrity and airworthiness of ageing aircraft are fatigue and corrosion. Corrosion alone is estimated to cost the Australian Defence Force \$245 million per annum with the total cost to the nation being in the order of \$30 billion annually.

The airframes of military and civil aircraft contain a very large number of fastened joints. For example, the Boeing 747 is reported to include over six million parts, half of which are fasteners. It is therefore vital that all aspects of the corrosion and fatigue behaviour of aircraft fastened joints are fully understood to reduce the capability impacts caused by unscheduled maintenance on aircraft.

This research will involve experimental and finite element investigation into the mechanical behaviour of fastened joints used in aircraft. There are a range of possible summer projects within this broader project.

**Project supervisor(s):** Please contact [Dr John Codrington](#) for further information.

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**Project title:** Magnetic levitation devices: modelling, coding, and experimentally testing new solutions for magnetic fields and forces

**Research theme(s):** Defence, Cyber and Space

**Project description:** Magnetic fields and forces are usually calculated with finite element analysis, which is a general solution but is extremely slow for even simple geometries. Our research group builds new models for calculating fields and forces with analytical models and semi-analytical interpretations of the fundamental equations of magnetism (e.g., as derived from Maxwell's equations).

These models are hundreds of times faster than FEA, but have only been derived and tested for specific geometries. We are creating new solutions and amalgamating solutions from the literature in a [public code repository](#) for use by the general research community, to allow any engineer to use magnetic solutions in their designs without becoming experts in magnetism themselves.

This project is flexible to the interests of the student and could involve theory, programming, experimental testing, novel device design, or a combination of all.

**Project supervisor(s):** Please contact [Dr Will Robertson](#) for further information.

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**Project title:** Design and build a low-light UV imaging system

**Research theme(s):** Energy, Mining and Resources; Defence, Cyber and Space

**Project description:** Many applications in space, defence and scientific research require photographs to be recorded with very low levels of light. This project will use technology similar to "night vision goggles" to enable imaging of low levels of UV light. The project can be tailored to suit the applicant's interests in the relevant optics, mechanics and electronic aspects of the system.

**Project supervisor(s):** Please contact [Associate Professor Paul Medwell](#) for further information.

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**Project title: Spray flame modelling**

**Research theme(s):** Energy, Mining and Resources

**Project description:** The project will involve computational models of flames encountered in engines, particularly gas turbines. Students should have an interest in CFD and applying it to engine environments.

**Project supervisor(s):** Please contact [Associate Professor Paul Medwell](#) or [Dr Michael Evans](#) for further information.

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**Project title: High pressure combustion experiments for gas turbines**

**Research theme(s):** Energy, Mining and Resources; Defence, Cyber and Space

**Project description:** The project will use the University's large-scale combustor for performing experiments of flames at high pressure. The project is in collaboration with the US Air Force, and the outcomes will be relevant to next-generation gas turbines.

**Project supervisor(s):** Please contact [Associate Professor Paul Medwell](#) or [Dr Michael Evans](#) for further information.

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**Project title: Pipe Flow at Extreme Reynolds number**

**Research theme(s):** Energy, Mining and Resources; Agrifood and Wine

**Project description:** Water hammer in piping networks can cause damage to pipes resulting in loss of pressure within the pipe lines and wastage. Numerical and experimental studies will be performed to assess these water hammer effects in the pipe lines.

**Project supervisor(s):** Please contact [Dr Rey Chin](#) for further information.

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**Project title: Experiments on stented coronary arteries**

**Research theme(s):** Advanced Manufacturing; Functional Materials; Health and Biotechnology

**Project description:** Water hammer in piping networks can cause damage to pipes resulting in loss of pressure within the pipe lines and wastage. Numerical and experimental studies will be performed to assess these water hammer effects in the pipe lines.

**Project supervisor(s):** Please contact [Dr Rey Chin](#) for further information.

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**Project title: Rotating detonation engine (RDE) for supersonic flights**

**Research theme(s):** Energy, Mining and Resources; Defence, Cyber and Space

**Project description:** Numerical studies of rotating detonation engines.

**Project supervisor(s):** Please contact [Dr Rey Chin](#) for further information.

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**Project title: Drag reduction for shipping industry**

**Research theme(s):** Energy, Mining and Resources; Defence, Cyber and Space

**Project description:** Experimental and numerical studies of drag reduction performance of various ship hull coatings.

**Project supervisor(s):** Please contact [Dr Rey Chin](#) for further information.

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**Project title: Hypersonic flow in scramjets**

**Research theme(s):** Defence, Cyber and Space

**Project description:** Numerical studies of hypersonic flow in scramjets.

**Project supervisor(s):** Please contact [Dr Rey Chin](#) for further information.

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**Project title: Improving performance of morphing wing UAVs**

**Research theme(s):** Advanced Manufacturing; Functional Materials; Defence, Cyber and Space

**Project description:** Experimental and numerical studies of performance of morphing wing UAVs.

**Project supervisor(s):** Please contact [Dr Rey Chin](#) for further information.

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**Project title: Building the next generation of world class submarines**

**Research theme(s):** Energy, Mining and Resources; Defence, Cyber and Space

**Project description:** Please contact Dr Rey Chin for details related to this project.

**Project supervisor(s):** Please contact [Dr Rey Chin](#) for further information.

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**Project title: Numerical case study for COVID-19**

**Research theme(s):** Health and Biotechnology

**Project description:** A case study will be performed using numerical simulations to understand the spread of the virus in an enclosed environment.

**Project supervisor(s):** Please contact [Dr Rey Chin](#) for further information.

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**Project title: Nanotechnology: mechanical properties of nanodevices**

**Research theme(s):** Sustainable and Smart Built Environments; Advanced Manufacturing

**Project description:** For more information about this project, please contact Dr Mergen Ghayesh.

**Project supervisor(s):** [Dr Mergen Ghayesh](#)

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**Project title:** Nanotechnology: medical applications

**Research theme(s):** Health and Biotechnology; Energy, Mining and Resources

**Project description:** For more information about this project, please contact Dr Mergen Ghayesh.

**Project supervisor(s):** [Dr Mergen Ghayesh](#)

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**Project title:** Biomechanical analysis of aortic system for heart attack prediction

**Research theme(s):** Sustainable and Smart Built Environments; Health and Biotechnology

**Project description:** For more information about this project, please contact Dr Mergen Ghayesh.

**Project supervisor(s):** [Dr Mergen Ghayesh](#)

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**Project title:** Biomechanics of cardiovascular system

**Research theme(s):** Sustainable and Smart Built Environments; Health and Biotechnology

**Project description:** For more information about this project, please contact Dr Mergen Ghayesh.

**Project supervisor(s):** [Dr Mergen Ghayesh](#)

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**Project title:** Myocardial infarction prediction via mechanical analysis

**Research theme(s):** Advanced Manufacturing; Functional Materials

**Project description:** For more information about this project, please contact Dr Mergen Ghayesh.

**Project supervisor(s):** [Dr Mergen Ghayesh](#)

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**Project title:** Hyperelastic structures for soft robotics

**Research theme(s):** Advanced Manufacturing; Functional Materials

**Project description:** For more information about this project, please contact Dr Mergen Ghayesh.

**Project supervisor(s):** [Dr Mergen Ghayesh](#)

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**Project title:** CNT reinforced structures for seismic protection

**Research theme(s):** Sustainable and Smart Built Environments

**Project description:** For more information about this project, please contact Dr Mergen Ghayesh.

**Project supervisor(s):** [Dr Mergen Ghayesh](#)

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**Project title:** Nonlinear damping in micro and nano devices

**Research theme(s):** Sustainable and Smart Built Environments; Functional Materials

**Project description:** For more information about this project, please contact Dr Mergen Ghayesh.

**Project supervisor(s):** [Dr Mergen Ghayesh](#)

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**Project title:** Nanotechnology: viscoelastic behavior

**Research theme(s):** Sustainable and Smart Built Environments; Energy, Mining and Resources

**Project description:** Nanotechnology: mechanical properties of nanodevice.

**Project supervisor(s):** [Dr Mergen Ghayesh](#)

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**Project title:** Cervical spine bone quality and strength

**Research theme(s):** Health and Biotechnology

**Project description:** Osteoporosis of the spine is diagnosed clinically using DEXA scans of the lumbar spine. However, often only small segments of ex vivo cadaver spines are obtained for biomechanical testing, and in this case there is no standard way of determining if a specimen has suitable bone quality for the research question. The aim of this project is to develop a relationship between the bone density predicted by calibrated CT images of cervical spines, and the bone density measured at specific locations on microCT images, as well as the strength of the bone from mechanical testing.

**Project supervisor(s):** Please contact for [Dr Claire Jones](#) (Mechanical Engineering/Adelaide Medical School) and [Dr Ryan Quarrington](#) (Adelaide Medical School) for further information.

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**Project title:** New perspective from old data: a contemporary, quantitative analysis of the first reported cervical facet dislocation produced in the laboratory

**Research theme(s):** Health and Biotechnology

**Project description:** Subaxial cervical spine facet dislocation (CFD) is a devastating neck injury that is nearly always associated with a spinal cord injury. Despite several decades of experimental work, the biomechanics that lead to CFD are not well understood. Our research group was recently gifted the entire raw dataset from the first study (of only two) to systematically produce CFD in human cadaver cervical spines, originally published in 1978 by an Orthopaedic Surgeon from Adelaide. This dataset contains vital information about the biomechanics of CFD that were not reported in the original, largely overlooked, manuscript. In this project, we will apply modern image analysis techniques to this important dataset to quantitatively characterise the intervertebral motions and loads that occur during the progression of the CFD event.

**Project supervisor(s):** Please contact for [Dr Ryan Quarrington](#) (Adelaide Medical School) [Dr Claire Jones](#) (Mechanical Engineering/Adelaide Medical School) for further information.

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**Project title:** Human neck stiffness and range of motion

**Research theme(s):** Health and Biotechnology

**Project description:** The aim of this project is to determine human neck stiffness and range of motion from early to late adulthood. In this project, we are recruiting participants to undergo a specific test series in the motion capture laboratory. Working closely with the PhD student and supervisors, the student(s) may assist test set-up and participant tests, process motion capture, electromyography and load data, design and build apparatus, and/or write custom programs for data acquisition or processing.

**Project supervisor(s):** Please contact for [Dr Claire Jones](#) (Mechanical Engineering/Adelaide Medical School) and [Dr Ryan Quarrington](#) (Adelaide Medical School) for further information.

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**Project title:** Using microdrones to demonstrate effective intercepting strategy for aerial attack

**Research theme(s):** Defence, Cyber and Space

**Project description:** Intercepting ballistic attacks has always been a challenging research topic in defence science due to the unpredictable superior maneuverability of an attacker compared to interceptors.

Current defence guidance laws normally assume adequate superiority of the interceptor, which could be problematic due to the uncertainty of this condition in real life. In order to effectively intercept a superior attacker, new guidance laws must be investigated. To offset the quality inferiority of single interceptor, we use the quantity advantages of multiple interceptors against a superior attacker. Utilising the maximum acceleration of the attacker, we can define its covering range at any point in time.

This covering range is then matched up by deploying multiple interceptors to maximise the coverability. The success of the new control algorithm will be implemented and demonstrated through micro drone testing in a laboratory setting.

**Project supervisor:** Please contact [Dr Lei Chen](#) for further information.

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**Project title:** Using your maths skills to help miners increase profitability

**Research theme(s):** Energy, Mining and Resources

**Project description:** Your maths skills can be useful in developing new technique which enables mining operators to select appropriate feed rates of mills, thereby providing optimal throughput and prevent the clogging of mills that causes downtime. Through this practice you will gain insight the importance of math in engineering and how to use the skills to save energy and increase productivity and profitability.

**Project supervisor:** Please contact [Dr Lei Chen](#) for further information.

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**Project title:** Testing thermal runaway of Li-ion batteries for explosion-proof

**Research theme(s):** Energy, Mining and Resources; Agrifood and Wine

**Project description:** Li-ion battery driven electric vehicles are used for underground mine, defence, agrifood and wine industries with explosion-proof issues. Especially for application such as underground mines or agrifood and wine warehouse, there are gassy environments, such as internal methane air mixture, which are prone to surrounding explosive atmosphere. When Li-ion batteries are under thermal runaway, such as overcharging, pressurized enclosures are created. The relationship between the contents and status of different Li-ion batteries and the thermal runaway is unknown to many users. It is the purpose of this project to test the relationship and build a mathematical model for different types of batteries.

**Project supervisor:** Please contact [Dr Lei Chen](#) for further information.

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**Project title: Bioinspired Autonomous Underwater Vehicle**

**Research theme(s):** Defence, Cyber and Space

**Project description:** Autonomous Underwater Vehicles (AUVs) are tasked to explore and sense extreme environments. Many natural organisms are very capable under these conditions, and can provide wide ranging inspiration for robotics engineers. In 2019, an honours project was started that has created a biologically inspired cuttlefish AUV, with the project winning the Ingenuity Innovation award as well as an international innovation competition run by Ericsson (<https://www.ericsson.com/en/news/2019/12/eia-2019>). The AUV has been further improved by an honours group in 2020. This summer research project aims to take the existing platforms and extend the work by investigating the propulsion efficiency and manoeuvrability, both in simulation and water tunnel tests. This work will be vital in exploring what this innovative system can achieve.

**Project supervisor:** Please contact [Dr David Harvey](#) or [Associate Professor Eric Fusil](#) for further information.

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**Project title: Mobile robot swarm implementation**

**Research theme(s):** Defence, Cyber and Space

**Project description:** The University has four highly articulated rover robots from Capra robotics (<https://capra.ooo/>). We plan to use them to explore biologically-inspired swarm robotics for low-gravity off-planetary tasks that would help establish a permanent human presence in space. This project will help to set up a robotics arena at the university, explore the current state of swarm robotics and program the Capra robots to demonstrate swarm behaviour in the arena. This demonstration will have these robots operating to complete infrastructure-related tasks together on a sandy / rocky surface, with the possibility of a combination of autonomous behaviour and remote human operation. It will build upon the University's participation in the NASA Space Robotics Challenge (<https://spacecenter.org/space-robotics-challenge/space-robotics-challenge-phase-2/>) transferring lessons learned in the virtual environment to the real world. The project will involve using Python, ROS and Gazebo, so experience in these would be welcomed, though is not vital.

**Project supervisor:** Please contact [Dr David Harvey](#) or [Associate Professor John Culton](#) for further information.

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**Project title: Airless Bicycle Tyres**

**Research theme(s):** Advanced Manufacturing

**Project description:** Yes, it has been done before. Take a look at this video: <https://www.youtube.com/watch?v=omQzHD7WWGk&feature=youtu.be>

We have a BigRep printer, just like the one in the video, so we can do this too. But should we? Yes, we should. However, this time we want to look at road and track racing tyres to see if we can reduce rolling resistance whilst maintaining grip and handling (as well as avoiding punctures). We are currently building a rolling resistance measurement rig, so we will be able to compare the rolling resistances of different designs easily. We also have an instrumented bicycle (IMU and other sensors attached) and access to a velodrome and elite cyclists, so we can assess tyre grip, handling and responsiveness as well. If you want a challenging project that has the potential to take you to the forefront of cycling research, this project is for you.

**Project supervisor:** Please contact [Associate Professor Richard Kelso](#) for further information.

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**Project title: HPV Wind Tunnel Drag Platform**

**Research theme(s):** Health and Biotechnology; Advanced Manufacturing

**Project description:** We require a wind tunnel drag measurement system for several projects involving human-powered vehicles, including full-sized Paralympic hand cycles and Pedal-Prix cars. The system will be used in the 3m x 3m wind tunnel at the Thebarton campus. The project entails the mechanical and structural design of the platform, selection of a load cell and computer interface, supervision of the fabrication by workshop technicians, then the assembly and testing of the system. The project could potentially lead to an Honours project involving the aerodynamic development or optimisation of a human-powered vehicle.

**Project supervisor:** Please contact [Associate Professor Richard Kelso](#) for further information.

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**Project title: Contact Forces in Cycling**

**Research theme(s):** Health and Biotechnology; Advanced Manufacturing

**Project description:** An instrumented bicycle has recently been developed at the UofA incorporating two 6-component load cells to measure the contact forces between a rider and the bicycle. The load cells are fitted to the bicycle's handlebar stem and seat post and are interfaced with a stand-alone data-acquisition system. Pedal forces are measured also. The system's hardware is complete and functions correctly, delivering excellent results. This project will use the system to measure contact forces during a range of cycling activities in an effort to understand issues such as the cyclist's weight distribution, vibration and maximum forces under different riding conditions. The results may potentially contribute to our understanding of problems such as hand numbness, saddle sores and rider fatigue, and may be used to inform bicycle component design.

**Project supervisor:** Please contact [Associate Professor Richard Kelso](#) for further information.

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**Project title: Flow field aerodynamics for heliostat wind load reduction**

**Research theme(s):** Energy, Mining and Resources

**Project description:** Reflecting mirrors "heliostats" are arranged in rows surrounding a central tower to maximise the efficiency of thermal energy collected at the receiver in a concentrating solar thermal plant. This project will utilise the large-scale University of Adelaide wind tunnel to develop relationships between the wind loads on heliostats in staggered and tandem field arrangements, with the goal of reducing the capital cost of manufacturing the heliostat components for commercial projects.

This work is for the Australian Solar Thermal Research Institute (ASTRI) heliostat project, in collaboration with CSIRO and ANU, and funded by the Australian Renewable Energy Agency (ARENA). For further information, please visit <https://www.adelaide.edu.au/cet/technologies/heliostat-wind-loads>

**Project supervisor:** Please contact [Dr Matthew Emes](#) or [Associate Professor Maziar Arjomandi](#) (Mechanical Engineering/Centre for Energy Technology) for further information

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**Project title: Modelling of heliostat field flow behaviour and aerodynamics**

**Research theme(s):** Energy, Mining and Resources

**Project description:** Reflecting mirrors "heliostats" are arranged in rows surrounding a central tower to maximise the efficiency of thermal energy collected at the receiver in a concentrating solar thermal plant. This project will develop a CFD model of the flow behaviour and heliostat aerodynamics within a field, with the goal of reducing the capital cost of manufacturing the heliostat components for commercial projects.

This work is for the Australian Solar Thermal Research Institute (ASTRI) heliostat project, in collaboration with CSIRO and ANU, and funded by the Australian Renewable Energy Agency (ARENA). For further information, please visit <https://www.adelaide.edu.au/cet/technologies/heliostat-wind-loads>

**Project supervisor:** Please contact [Dr Matthew Emes](#) or [Associate Professor Maziar Arjomandi](#) (Mechanical Engineering/Centre for Energy Technology) for further information

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**Project title:** Surface modifications for drag reduction

**Research theme(s):** Energy, Mining and Resources; Defence, Cyber and Space

**Project description:** Skin friction drag is the main source of drag in many natural and engineering applications, such as aircraft, ships, high speed vehicles and gas pipelines. It is estimated that a small reduction of 5% in skin friction drag will result in an annual saving of approximately \$3.3 billion US dollars for the global fleet. In this project, a method for reducing the drag on a flat plate by application of wall surface modifications is investigated. The project involves design and experimental testing of the model in a wind tunnel.

**Project supervisor:** Please contact [Associate Professor Maziar Arjomandi](#) or [Azadeh Jafari](#) for further information.

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**Project title:** A novel technique for drag measurement

**Research theme(s):** Energy, Mining and Resources; Defence, Cyber and Space

**Project description:** Skin friction drag is the main source of drag in many natural and engineering applications, such as aircraft, ships, high speed vehicles and gas pipelines. It is estimated that a small reduction of 5% in skin friction drag will result in an annual saving of approximately \$3.3 billion US dollars for the global fleet. Therefore, turbulent skin friction drag reduction is an active research area due to its tremendous potential impacts on the global economy and ecology. However, measuring the small change in the drag force in a laboratory is a challenge and requires a highly sensitive and accurate measurement technique. This project aims to develop and build an innovative solution for drag measurement.

**Project supervisor:** Please contact [Associate Professor Maziar Arjomandi](#) or [Azadeh Jafari](#) for further information.

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**Project title:** Measurement of aerodynamic loads on a flapping-wing unmanned aerial vehicle (UAV)

**Research theme(s):** Energy, Mining and Resources; Defence, Cyber and Space

**Project description:** Lapping mechanism is essential in smaller aerial vehicles to generate higher lift in spite of their lower inertia. Development of flapping-wing models requires accurate prediction of aerodynamic loads for their optimal design. However, measurements of the small-magnitude loads on smaller UAVs is a challenge. Most industrial-scale load cells are capable of measuring very large forces with insufficient resolution for measuring the aerodynamic loads on a UAV. In this project, a novel design of a load cell will be developed, taking into account the recent advances in the load-cell design.

**Project supervisor:** Please contact [Associate Professor Maziar Arjomandi](#) or [Dr Shantanu Bhat](#) for further information.

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# AIML

## Australian Institute for Machine Learning

**Project title:** Solving Noisy Label Deep Learning with Data Augmentation

**Research theme(s):** Health and Biotechnology; Advanced Manufacturing

**Project description:** Deep learning modelling relies on well curated and balanced large-scale datasets, where the labels associated with samples were correctly provided by human annotators. Nevertheless, most real world large-scale datasets contain labels that have an imbalanced prevalence, and may contain incorrect information. Many techniques have been studied to enable the training of deep learning models using these types of datasets, where the state-of-the-art approaches tend to comprise a set of different techniques. In this summer internship, we will study a recently developed method and extend it with new types of data augmentation that can potentially improve its performance. We already have a code base and relevant datasets, so the task of the intern is to implement and analyse the new types of data augmentation. If results are relevant, this work can be potentially submitted to top conferences in computer vision and machine learning.

**Project supervisor(s):** Please contact [Professor Gustavo Carneiro](#) for further information.

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**Project title:** Bayesian Noisy Label Deep Learning

**Research theme(s):** Advanced Manufacturing

**Project description:** Deep learning relies on well curated large-scale datasets that have a well-balanced class prevalence and correct labels. Nevertheless, most real world large-scale datasets contain labels that have an imbalanced prevalence, besides being incorrect. Most of the state-of-the-art methods that address this problem involve a way to estimate the correctness of the label associated with a training sample. This estimation is typically based on the loss values, which is unable to separate hard samples to classify from samples containing incorrect labels. In this project, we plan to address this issue with Bayesian learning, where we will study if high uncertainty can be associated with incorrectly labelled samples. We already have a code base and datasets to be used as testbed, and the intern is expected to implement the Bayesian learning and inference methods. If results are relevant, we plan to submit this work to major computer vision and machine learning conferences.

**Project supervisor(s):** Please contact [Professor Gustavo Carneiro](#) for further information.

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**Project title:** What can we Infer from Results on Noisy Label Datasets?

**Research theme(s):** Advanced Manufacturing

**Project description:** Deep learning modelling relies on well curated large-scale datasets, where the labels associated with samples are balanced and correct. Nevertheless, most real world large-scale datasets contain labels that have an imbalanced prevalence, besides being incorrect. There are several approaches that can be trained with noisy-label datasets, and their performance is then tested on a clean dataset. This setup is quite unrealistic since it is unlikely that we will have a clean dataset available for testing the system. Hence, the question posed in this research is: can we estimate the performance of one of the approaches above on a clean dataset by training and testing using noisy-label datasets? We have a codebase and datasets already available, and we expect the intern to analyse the results to see if it is possible to provide such estimation. We plan to publish the result of this result, depending on the success of the estimation.

**Project supervisor(s):** Please contact [Professor Gustavo Carneiro](#) for further information.

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**Project title: Deep Learning for Visual Defect Detection**

**Research theme(s):** Energy, Mining & Resources; Functional Materials

**Project description:** This project explores the use of deep learning techniques to have automatic identification of defects in surface of large-scale infrastructure facilities or materials, such as photovoltaic (PV) power plants, housing/transportation materials. While there can be different types of data available for this purpose, we focus on image data of these infrastructure facilities or materials.

**Project supervisor(s):** Please contact [Dr Guansong Pang](#) for further information.

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**Project title: Development and Deployment of Novel Machine Learning Techniques for Physics Problems**

**Research theme(s):** Defence, Cyber and Space

**Project description:** There are a number of projects offered in conjunction with the physics department, all of which involve the development and deployment of novel machine learning techniques:

- a) Development of anomaly detection algorithms for making new discoveries at the Large Hadron Collider.
- b) Development of techniques for processing images taken with the Cherenkov Telescope Array (a gamma ray astronomy experiment).
- c) Development of new techniques for optimisation problems.
- d) Space debris modelling.

**Project supervisor(s):** Please contact [Professor Martin White](#) or [Dr Zygmunt Szpak](#) for further information.

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# CASR

## Centre for Automotive Safety Research

**Project title:** Linking a large dataset of vehicle trips to the attributes of the travelled roads using a map-matching approach

**Project description:** Implement a map-matching approach to associate the GPS coordinates collected during a vehicle trip to the attributes of the roads through which the vehicle travelled (e.g., type of road, road speed limit, number of lanes). The code developed as part of this project is expected to automatically input the trip relevant GPS coordinates from an existing large dataset, map-match the trip to a digital map system (Open Street maps) and extract the relevant road attributes into a database that could be used for future analysis of those trips. Matlab or Python are the preferred programming languages, but open to consider also other options if needed.

**Project supervisor(s):** Please contact [Dr Mario Mongiardini](#) for further information.

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**Project title:** Optimisation of road safety infrastructure investment

**Project description:** CASR has created a numerical model to evaluate the road safety benefits of infrastructure investments made into the road transportation system. This work will inform future road safety strategies and other crucial policies developed for South Australia. In this project, you will be able to contribute to this work by developing a version of the model compatible with computational optimisation algorithms. An understanding of computational optimisation techniques and some experience with the application of these techniques is advantageous.

**Project supervisor(s):** Please contact Chris Stokes for further information.

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**Project title:** *Aligning road network risk ratings with the Safe System*

**Project description:** The Safe System is regarded as leading-philosophy in road safety. At the same time, road network risk rating systems have become a leading tool for enabling proactive investment into road safety. This project will help to improve the alignment between road network risk rating systems and the Safe System philosophy upon which road safety is modelled. In this project, you will develop a framework for assessing this alignment by matching road network risk rating model attributes to the benchmarking methods used to prioritise road safety infrastructure under the Safe System.

**Project supervisor(s):** Please contact Chris Stokes for further information.

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**Project title:** *Investigating the factors which affect cyclist passing distances, using mass naturalistic data collection*

**Project description:** Instigating a mass naturalistic data collection program, involving the deployment of lateral passing distance measurement devices with volunteer cyclists, and processing the results to identify what factors result in more dangerous passing events.

**Project supervisor(s):** Please contact [Dr Jamie Mackenzie](#) for further information.

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# TRC

## Teletraffic Research Centre

**Project title:** Indoor Positioning using Visible Light

**Research theme(s):** Advanced Manufacturing

**Project description:** Indoor positioning systems (IPSs) underpin applications in diverse areas such as automatic systems, indoor navigation, and Industry 4.0. The demand for highly accurate low-cost indoor positioning systems is rapidly increasing. For example, in a car park with limited sky view, where Global Positioning System (GPS) performs poorly, an IPS will be required for an autonomous car to locate itself.

This project aims at innovating a novel IPS using visible light. Based on a new idea that was recently developed with an industry partner from Europe, we will build a prototype device and use it to take some measurements. The student will be guided to build a mathematical model from the measured results and write simulation programs to explore different scenarios. Basic knowledge in programming is required.

**Project supervisor(s):** Please contact [Dr Siu Wai Ho](#) for further information.

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**Project title:** Real-Time Network Segmentation and Segregation using Graph Convolutional Neural Networks

**Research theme(s):** Defence, Cyber and Space

**Project description:** Network segmentation involves partitioning a network into smaller networks, while network segregation involves enforcing security rules to restrict access to hosts and services only when required and authorized. Through network segmentation and segregation, the access to sensitive information, hosts and services can be restricted without affecting the organization and operation of the business. Network segmentation and segregation is one of the most effective techniques to prevent attacks and limit their impact. Most current AI solutions often indiscriminately block all network traffic on all ports and connections, rather than considering the role of each machine and the motive behind the compromise attempts as a human defender might. These solutions thus unnecessarily disable communications that are key to business operations. The main idea of the project is to develop segmentation and segregation methods that ensure operation continuity by creating a system of prevention and recovery from potential threats to the network infrastructure.

**Project supervisor(s):** Please contact [Dr Hung Nguyen](#) for further information.

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**Project title:** Provable Network Security with Mechanism Design

**Research theme(s):** Defence, Cyber and Space

**Project description:** Security games provide an analytical framework for modelling the interaction between the attacker, who aims to access a particular network resource, and the defensive agent who tries to stop the attacker. Mechanism design is a field in game theory that takes an objectives-first approach to designing mechanisms toward desired objectives. In this project, we will explore how to apply mechanism design to build network and security policies that guarantee that the defender always succeeds in securing the network and critical data. Of particular interest is the Gibbard–Satterthwaite impossibility theorem - that for a general class of games, only "dictatorial" social choice functions can be implemented. That is, it's only possible to design a game where one agent always receives his most-favored goods allocation. We will investigate if we can use this theorem to the network defender's advantage to design network and security policies where he is the "dictator".

**Project supervisor(s):** Please contact [Dr Hung Nguyen](#) for further information.

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**Project title:** Efficient exploration in repeated games

**Research theme(s):** Defence, Cyber and Space

**Project description:** News websites have to make decisions about which articles to display to visitors. With no information about the visitor, visitor responses (clicks) are unknown. The website's goal is typically to maximize engagement, but they have many pieces of content from which to choose, but they lack crucial data to help choose a strategy 'optimally'. So, which articles will get the most clicks? And in which order should they appear? Similar problems face online advertisers, or online retail stores.

The multi-armed bandit literature makes this problem concrete and series rigorous bounds on the fundamental 'exploration vs. exploitation' dilemma for these stochastic environments. However, what happens if the environment is adversarial? What if you are not interacting with a largely passive audience but active players? This project investigates the emerging problems of exploration vs. exploitation in a game theoretic setting of a two-player game, where one player has an opportunity to simulate the game before play. The project will focus on modelling and some simple simulations.

**Project supervisor(s):** Please contact [Dr George Stamatescu](#) or [Dr Hung Nguyen](#) for further information.

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**Project title:** Exploring and exploiting mistakes in games

**Research theme(s):** Defence, Cyber and Space

**Project description:** Algorithmic game theory has recently made advances in the performance of computers in

complex games such as Poker. However, during the early stages of learning the algorithms are likely to make "mistakes", which have been recently defined as moves that receive zero probability under any Nash equilibrium.

This project investigates how different learning algorithms, which attempt to learn "good" strategies for the game, might leave themselves open to exploitation. Is it possible to design algorithms which can quickly detect mistakes? Or is it possible to strategically teach an opponent to secure some payoff?

The project will focus on formulating these questions rigorously, modelling the games and simple simulations, possibly using the new OpenSpiel library.

**Project supervisor(s):** Please contact [Dr George Stamatescu](#) or [Dr Hung Nguyen](#) for further information.

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