Flinders University

COLLEGE OF SCIENCE AND ENGINEERING

STUDENT RESEARCH EXPERIENCE AWARD

PROJECT BOOKLET 2024 - 2025

INTRODUCTION

At the College of Science and Engineering we believe in the power of science and engineering to solve real world problems.

We strive to advance fundamental science, to create new technologies, and to work across discipline boundaries. Our interests scale from the sub-atomic through to entire oceans, forests and beyond. We seek to understand the past, but also to create the world of the future.

Our researchers seek to discover new understandings in fields as diverse as groundwater hydrology, forensic science and medical devices, while our teaching offers training in areas of biological sciences, chemical and physical sciences, computer science, information technology, engineering, mathematics and the environment.

Our college is an exciting place to research, study and work, supported by best practice teaching methods, practical work-related learning and advanced facilities.

We are the power behind creative science and engineering.

RESEARCH SECTIONS

Our talented researchers span across all spheres of science and engineering and bravely pursue solutions to some of the biggest questions of our time. With a broad focus on sustainability, security and health, our research advances knowledge, addresses real world problems, and promotes sustainable development.

Our multidisciplinary research sections provide areas of foci for our research community and encompass the following:

- Ecology, evolution and environment
- Data and information science
- Engineered systems
- Molecular science and technology

ECOLOGY, EVOLUTION AND ENVIRONMENT

We do broad and interdisciplinary research in ecology, evolution and the environment and are committed to produce world-class scientists through our Honours and PhD programs. Our work addresses questions at a range of spatial and temporal scales, from microhabitat to global, and from generations to millennia. We study a variety of terrestrial and aquatic environments and organisms, ranging from the arid-zone to the deep sea and from bacteria to whales.

We do world-leading research in several areas of biodiversity and environmental sciences, including palaeontology, evolutionary biology, global ecology, molecular ecology, animal behaviour, groundwater and coastal geomorphology.

Our research is expanding knowledge about the history of life and the potential of organisms to adapt to environmental change. We are also interested in improving water management and understanding the impact of human activities on the physical environment, biodiversity and natural resources. Our research section consists of around 180 academics, postdocs and research students housed at the leafy surrounds of the Flinders University campus at Bedford Park.

RESEARCH AREAS

- Hydrology
- Ecology and conservation
- Environmental Health
- Evolutionary biology and palaeontology
- Marine and Coastal Sciences

DATA AND INFORMATION SCIENCE

In today's data driven world, our data and information science, computer science and mathematics researchers are at the forefront of creating practical solutions to real-world challenges. By embracing the rapidly changing technological environment, our research takes fundamental science and applies it to areas including agriculture, healthcare, and defence.

We focus on the integration of cybersecurity, machine learning and advanced data analytics to solving important and wide-reaching industry, government, and defence problems.

Our mathematicians and computer scientists are conducting world-leading research in artificial Intelligence, knowledge discovery, medical image processing, neuroscience, and cybersecurity. Our experts in digital health are making significant contributions to healthcare service delivery world-wide, creating new systems for data security, virtual care and digital infrastructure.

Conducting inter-disciplinary and collaborative research, we translate our research into tangible outcomes with broad impact for the benefit of the professions and the community.

RESEARCH AREAS

- Knowledge Discovery, AI and Data Mining
- Digital Health
- Cybersecurity and Networking
- Mathematical Analysis
- HCI, Simulation and Visualisation

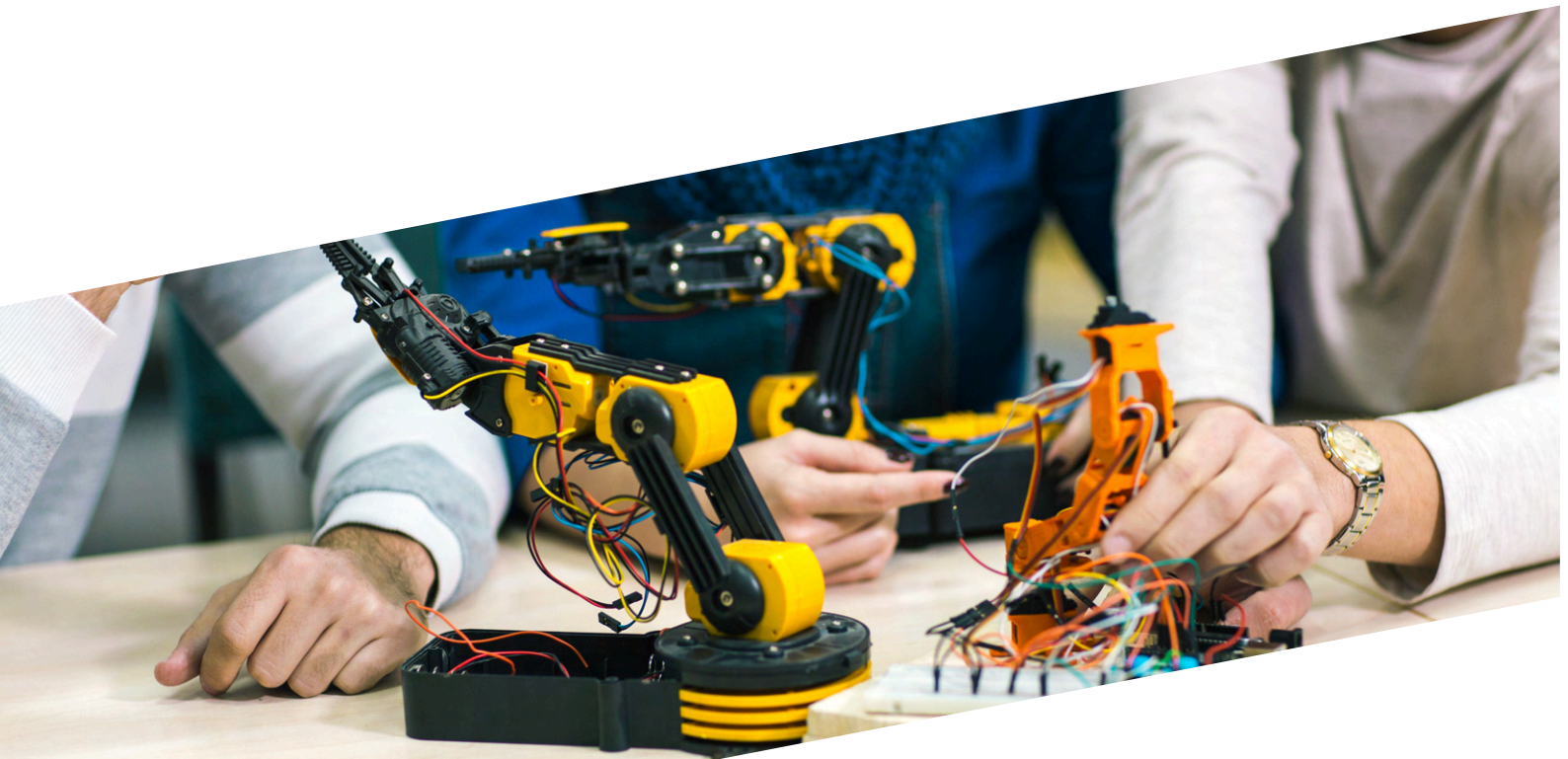
ENGINEERED SYSTEMS

We are dynamic critical thinkers and problem solvers who are undertaking research across diverse fields of engineering, including medical devices, defence and maritime capabilities for the future.

By combining fundamental research with the application of state-of-the-art engineering principles, we are developing new technologies and making new breakthroughs in Biomedical, Civil & Environmental, Electrical & Electronic, Control, Mechatronics & Robotics, Materials, Mechanical & Manufacturing Engineering. Based at Tonsley, Australia's first Innovation District, our research incorporates strong collaborations with industry, across Australia and internationally.

RESEARCH AREAS

- Automation, Control & Robotics Engineering
- Biomedical Engineering
- Civil & Environmental Engineering
- Defence & Maritime
- Electrical & Electronic Engineering
- Materials, Mechanical and Manufacturing Engineering



MOLECULAR SCIENCE AND TECHNOLOGY

From the smallest units of matter to the molecular systems of life, we are growing knowledge and developing technology to answer some of the world's biggest challenges.

Our research in physics, chemistry, molecular biology, and plant science is world-leading and dedicated to expanding our understanding of the physical and biological world.

We are also committed to translating this fundamental research into a wide array of real-world applications and impact. Our chemistry and physics discoveries have led to new nanotechnology for environmental remediation, energy production and storage, and advanced materials. Our biochemical research has made an impact on how we view and treat disease. Our forensic science research has provided innovative solutions for fighting crime. Our plant science research has made advances to support the future of food production.

We are forward-thinking and aim for scientific and technological advances for solutions spanning health, development, security and sustainability.

RESEARCH AREAS

- Physics
- Chemistry
- Molecular biosciences
- Plant biology
- Nanotechnology
- Forensic science

PROJECT:
Investigating sources of nutrients to Coffin Bay

Coffin Bay (South Australia) is showing signs of water quality decline. However, the sources and rates of nutrient inputs to the Bay are presently unknown. Flinders University is currently leading a multi-institutional project to examine groundwater and surface water pathways for nutrient transport to Coffin Bay through an Australian Research Linkage project supported by multiple industry partners.

The student will explore existing datasets from sampling in the study area to assess water and nutrient movements, while learning new skills in mapping, hydrogeology and hydrochemistry. The project will inform important questions around the health and vulnerability of Coffin Bay, which is heavily relied upon by the oyster and tourism industries.

The student will be part of a large team of scientists and engineers specialising in various aspects of the water cycle, with guidance from Australia's leading experts in coastal hydrogeology, and with links to industry partners who rely on the ARC project's outputs to guide decision making.

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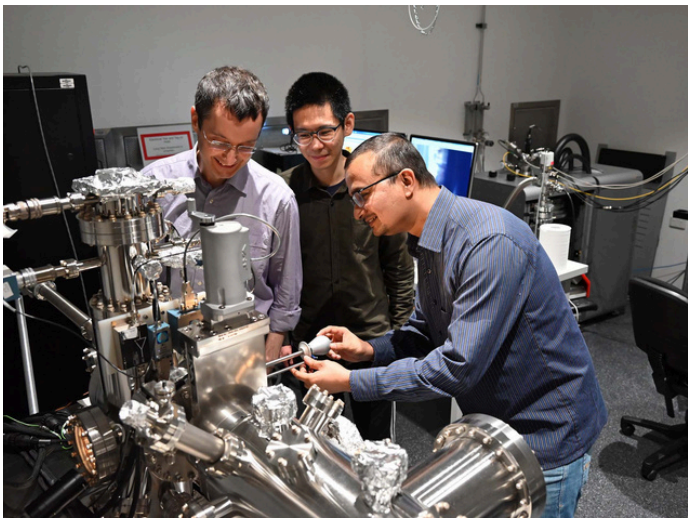
PROJECT:
Scanning probe microscopy of nanoscale polar textures

Herbert Kroemer, Physics Nobel Laureate in 2000, is often quoted for his dictum, "the interface is the device." In advanced ferroelectric electronic materials, nanoscale polarization textures, such as polar domains and walls, naturally form. These textures exhibit unique electronic properties different from the bulk material and can be electrically programmed—allowing for their creation, erasure, and displacement on demand. We are currently developing these nanoscale features for applications in memory, sensing, and brain-inspired neuromorphic computing.

As part of this project, students will gain hands-on skills and knowledge by utilizing scanning probe microscopy and spectroscopic techniques to study these exotic polarization textures at the nanometer scale.



SUPERVISOR DETAILS

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PROJECT:
The effect of temperature on Port Jackson shark microbiomes

The project will investigate the microbial community associated with Port Jackson sharks that have been exposed to low acid and high temperature. The students will analyse the number of microbes and viruses under each condition and conduct analysis of growth and antibiotic resistance on the microbes collected at high and low temperatures. Last the students will extract the DNA that has been collect during the experiment in preparation for metagenomic analysis.

SUPERVISOR DETAILS

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PROJECT:
Exploring maximum crossing numbers

The field of Graph Drawing is concerned with ways of visually representing graphs or networks. The aim is to produce drawings which make the graph easier to understand, as well as more aesthetically pleasing for the viewer. This is often done in an automated or semi-automated fashion by attempting to optimise the drawing according to various characteristics. One such characteristic is the number of “crossings”, which are points of intersection between the edges in the graphs. Although crossings can be informative in certain circumstances, more commonly they just add to the visual noise of the graph. As such, it is typically desirable to minimise them.

A fundamental question in this field involves asking about the worst-case scenario. Assuming certain conventions are met (edges can only cross once, and edges cannot cross if they are incident on a common vertex), it is easy to work out an upper bound on the maximum number of crossings in a given graph. If the graph can be drawn in such a way that this upper bound is met, the drawing is called a “thrackle” and the graph is said to be “thrackleable”. However, most graphs are not thrackleable. The question then is, what is the maximum crossing number for any given graph?

This problem is extremely difficult to solve computationally, even for very small graphs. An example, which we intend to focus on, is the graph C3 x C3. Although this graph has only nine vertices, its maximum crossing number is still unknown. Previous studies have shown that it must lie somewhere between 68 and 80 crossings. We have been looking at this graph, and have started to develop some computational techniques which will help us to determine the precise maximum crossing number for this case. We expect that the techniques developed in this project could then be applied to some larger graphs as well.

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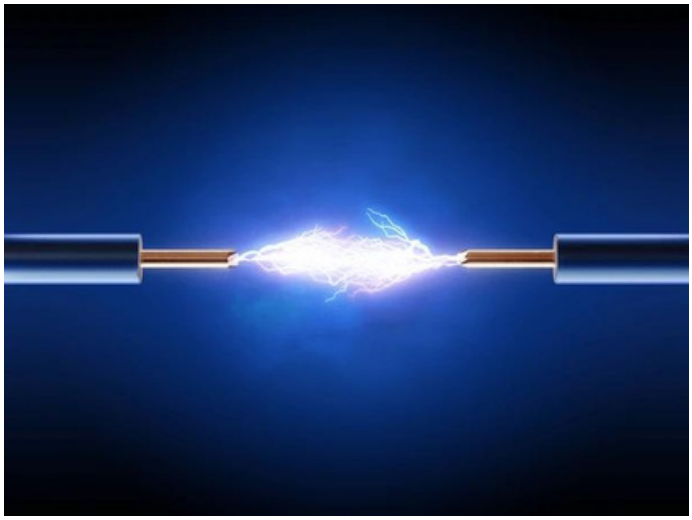
PROJECT:
Electrophotocatalysis: New catalysts to harness electricity and visible light for chemical synthesis

Aim 1: Design, synthesise, and evaluate gold-N-heterocyclic carbene (Au-NHC) electrophotocatalysts.
Robust catalysts with longer excited-state lifetimes will be synthesised, and their electrochemical and photophysical properties optimised. An electrochemical method has been developed to streamline access to Au-NHC complexes, opening up a new class of electrophotocatalyst. 2 Chromophores with varying functional groups will be added to the Au-NHC complexes to yield new electrophotocatalysts that will be extensively characterised and benchmarked in electrophotocatalytic methodology.

Aim 2: Development of synthetic methodology using gold N-heterocyclic carbene electrophotocatalysts.
The catalysts produced in Aim 1 will be used to develop new electrophotocatalysed synthetic methodology to establish access to extensive chemical libraries that cannot be synthesised readily in any other way. The new methods are expected to be inherently sustainable, use abundant feedstock chemicals as starting materials, and reduce waste streams.



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PROJECT:
Response of piles under under monotonic and cyclic lateral loading

Offshore wind farms are gaining popularity around the world due to the demand for clean renewable energy. For example, more than 3500 offshore wind turbines have been installed around European coastlines. In Australia, Victorian-based Offshore Energy announced a plan for Australia's first offshore windfarm off the coast of Gippsland in Dec 2017. The $8 billion project will include up to 250 turbines within a 574 square kilometre area, delivering approximately 8,000GWh of electricity per year, approximately 18% of Victoria's power usage.

The preferred foundations for the majority of the offshore wind turbines are monopiles. A monopile is a single large diameter driven pile. Early installed monopiles have diameters around 4-6 m and driven 20-30 m into the seabed, thus giving an embedded length to diameter ratio of approximately 5. Recently constructed monopiles have been extended to 7.5 m in diameter and future designs with diameter up to 10 m are anticipated. These monopiles are subjected to large cyclic, lateral and moment loads in addition to the axial loads during their design life. The aim of this project is to model, both experimentally and analytically, the behaviour of monopiles subjected to lateral loading. The project will focus on both monotonic loading as well as cyclic loading.

Specific objectives of the research are:

1. To carry out laboratory tests to investigate the long term performance of the monopile foundations in sand under a large number of lateral load cycles withlow or intermediate amplitudes.
2. To compile a database of piles under monotonic and cyclic lateral loading for calibration of the newly developed analytical solutions in cohesive frictionalgeomaterials;
3. To optimise and improve the current design methods for offshore wind turbine monopiles.

SUPERVISOR DETAILS

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PROJECT:
Drinking water as a source of healthcare associated infections

Healthcare-associated infections (HAIs) pose a significant threat to patient safety, and understanding their sources is crucial for prevention. This project focuses on the role that drinking water systems within healthcare facilities may play in the transmission of these infections. Over a 4-6 week period, you will participate in a comprehensive investigation to identify potential waterborne pathogens that could contribute to HAIs.

The project will involve the collection of biofilm and water samples from various points within the premise plumbing of different buildings. You will use selective culture techniques to isolate specific microorganisms from the samples, providing an initial identification. Following this, you will use polymerase chain reaction (PCR) to detect the various pathogens, offering a more detailed understanding of the microbial communities present.

Throughout this project, you will develop key laboratory skills, including sample collection, microbiological culturing, and molecular biology techniques. Additionally, you will learn to analyse and interpret the data you collect. This experience will not only enhance your practical skills but also contribute to the broader field of environmental health, helping to identify and mitigate sources of HAIs in drinking water systems.

SUPERVISOR DETAILS

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PROJECT:
Controlling fungal biofilms

Humans spend a large amount of time inside, as such, indoor air quality is strongly connected to health and wellbeing. Indoor environments can become contaminated with fungal biofilms resulting in a range of human health effects including respiratory conditions, infections, and allergic responses. Currently, there is limited scientific knowledge regarding the effectiveness of commercial antifungal agents against fungal biofilms and their ability to prevent regrowth. This study will collect fungal samples from South Australian buildings. The species will be identified and used to test the efficacy of a range of commercial disinfectants and cleaning products. This information will be used to inform guidelines for the control and remediation of buildings with indoor fungal contaminations resulting in improved indoor air quality.

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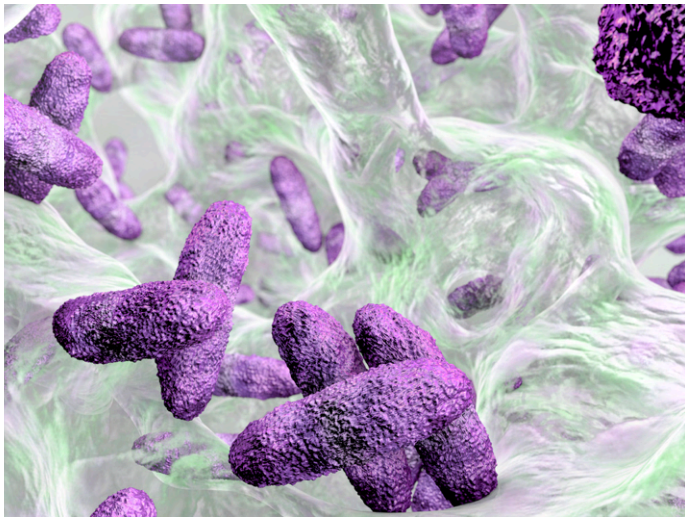
PROJECT:
Preventing hospital acquired infections

Pseudomonas aeruginosa is an opportunistic bacterial pathogen and a frequent cause of hospital and healthcare acquired infections. P. aeruginosa can cause a range of infections including blood, lung (pneumonia) and skin infection. It is predominately found in wet areas within hospitals including ventilators, humidifiers, sinks, taps and toilets. One of the challenges with controlling P. aeruginosa contamination of these sources is its ability to form biofilms.

This project will examine the effectiveness of commercially available hospital grade disinfectants against different strains of P. aeruginosa biofilms. This information will inform infection control guidelines to reduce healthcare associated infections.



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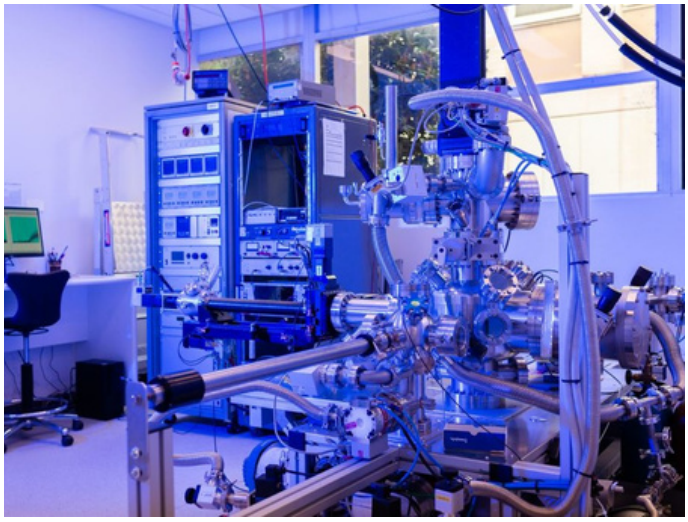
PROJECT:
Nano clusters for fabrication of solar fuels

We are developing catalysts for converting CO2 and H2O back to hydrocarbons, thus develop processes to fabricate solar fuels. The main components are small metal clusters which act as catalysts. The clusters contain only 4 – 100 metal atoms. We can be fabricated the clusters with physical methods in a cluster source or use chemically made clusters.

The project is a collaboration between Flinders, Adelaide University, the University of Tokyo (Japan) and the University of Utah (USA). We use electron spectroscopy and electron microscopy to analyse the photocatalysts and probe the efficiency of the photocatalysts.



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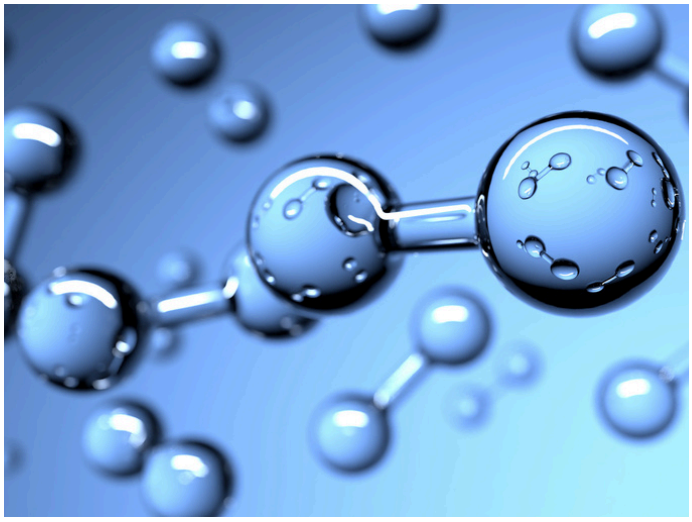
PROJECT:
Ions at Liquid Surfaces

Do ions like Cl- or Na+ adsorb at liquid surfaces? This is a question which has been hotly debated in Chemistry and Physics since a few decades. We have a unique surface spectroscopy technique (ion scattering spectroscopy) available to clarify this long standing problem. You will learn how to use this technique and help us making progress with clarifying this question which will be valuable for such diverse fields as battery technology, reactions in the atmosphere and formation of bubbles.

The project is a collaboration between Flinders, the University of Newcastle and the Australian national University.



SUPERVISOR DETAILS

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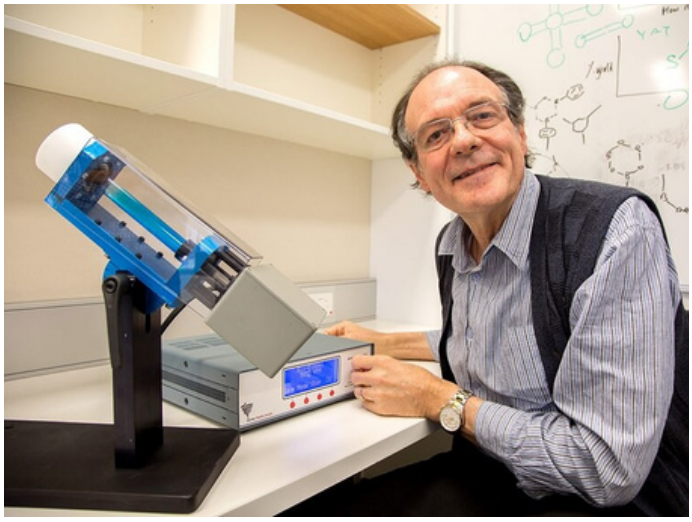
PROJECT:
Thin film microfluidics - fundamentals and applications

The vortex fluidic device (VFD) is a versatile thin film microfluidic platform with applications across the sciences and engineering, including in medical diagnosis, fabricating 2D materials, controlling chemical and enzymatic reactivity and selectivity, self-assembly, and food processing. Induced mechanical energy in the thin film of liquid in the tilted rotating tube is in the form of high shear topological fluid flow down to submicron dimensions. These are typhoon like and double helical flows which arise from Coriolis forces and Faraday waves. The VFD is designed to be able to add field effects to exquisitely control the fluid flow and the ensuing chemistry. Surprisingly the Earth's magnetic field can impact on the chemistry, and depending on the orientation of the rotating tube, material of absolute chirality can be generated by simply rotating the tube clockwise or counter clockwise. This is a paradigm shift in process chemistry in general, and the effects of applying an external (stronger) magnetic field heralds a paradigm shift in processing which is high in green chemistry (sustainability) metrics. The high shear generates hostile conditions that exist for a fraction of a second, and relate to the types of conditions in the environment and throughout the solar system and beyond.

Specific projects will depend on the interest of the students. They can be in medical applications, chemical synthesis, green shampoos, materials, mimicking solar system hostile conditions, and more.



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PROJECT:
Integrating Hand Tracking into Virtual Reality for Rehabilitation Applications

Virtual Reality (VR) is an area of growing interest due to its cross-disciplinary applications in health, manufacturing, architecture, defence, marketing, and gaming. As features such as controllerless hand tracking become more common and reliable, the applications to explore how humans engage and interact with virtual environments increase.

This project is designed to provide a student interested in VR for rehabilitation the opportunity to build and develop VR applications on a Meta Quest 3. This would be of significant benefit to a student interested in undertaking an honours or research project in the field of biomedical engineering or exploring the human-machine interaction in serious games.

It is expected that the student has prior experience with the Unity Game Engine, can program in C#, and has an interest in improving health outcomes through technology.

The primary learning objectives would involve:
1. Learning how to program hand tracking functions into a VR application
2. Learning how to use hand joint positions as inputs to functions
3. Learning how VR can translate into a rehabilitation tool

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PROJECT:
Languages Models to the Rescue: Uncovering Anomalies in Semantic Web Data

The semantic web (Web 3.0), with its intricate and interconnected data structures, is essential for enabling AI systems (such as digital assistants) to process and interpret information in a way that mimics human understanding. However, as the complexity of semantic web data increases, maintaining its accuracy and integrity becomes a significant challenge. Anomalies within this data, such as inconsistencies, errors, or unexpected patterns, can disrupt applications that rely on it, leading to incorrect outcomes or operational issues.

This project focuses on using existing Large Language Models (LLMs) to detect anomalies in semantic web data. Leveraging the deep contextual understanding of LLMs like GPT-4, the project aims to identify deviations from expected patterns in semantically rich data. Rather than training a new model, this approach utilizes pre-trained LLMs to analyze semantic web data and flag entries that differ significantly from established norms.

By applying these powerful LLMs to semantic web datasets, the project seeks to detect errors, inconsistencies, and other anomalies that could compromise the reliability of systems dependent on this data. The LLMs' ability to comprehend language and context enables them to identify subtle issues that might be missed by traditional methods.

This project aims to enhance the quality and reliability of semantic web technologies, ensuring more accurate AI-driven decision-making and robust knowledge management systems. The project will involve applying an existing LLM to real-world semantic web data, developing an anomaly detection framework, and evaluating its performance in uncovering both known and novel anomalies.

SUPERVISOR DETAILS

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PROJECT:
The diet of the central bearded dragon and sand goanna, two common large lizards in the Mid North of South Australia

In order to elucidate the ecology of gastrointestinal parasites and their hosts it is important to examine aspects such as the diet of the host as it usually determines which gastrointestinal parasites infects the host (Leung and Koprivnikar 2019). As part of the ongoing long-term ecological research on the sleepy lizard (Tiliqua rugosa) population in the vicinity of Bundey Bore Station in the Mid North region of South Australia central bearded dragons (Pogona vitticepts) and sand goannas (Varanus gouldii) that were found dead on roads (DOR) were collected and dissected to determine what endoparasites infected them (Norval et al. 2021).

This study will contribute to our understanding of the natural history of these lizards and their parasites by providing insight into their diet. For this study we will identify the dietary items of DOR central bearded dragons and sand goannas that were collected and dissected in 2022 and 2023. In the upcoming field season (August to December 2024) additional specimens will be collected if found, but not dissected. The student will be provided with the opportunity to dissect these specimens under supervision. From this study the student will gain and develop the following skills:

- The examining of large lizards for endoparasites
- Collecting and identifying stomach contents of large lizards
- Analysing stomach content data
- Reporting on the diet of a particular species

References:
Leung, T. L. F., and J. Koprivnikar. 2019. Your infections are what you eat: How host ecology shapes the helminth parasite communities of lizards. Journal of Animal Ecology 88:416-426.
Norval, G., C. R. Bursey, S. R. Goldberg, R. D. Sharrad, K. E. Ross, and M. G. Gardner. 2021. New host and locality records for gastrointestinal helminths of five reptile species from the Mid North region of South Australia. Transactions of the Royal Society of South Australia:1-15.

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PROJECT:
Coordinating Multi-Character Conversations between Large Language Models

Generative language models such as ChatGPT (OpenAI), Gemini (Google), Llama (Meta) and Copilot (Microsoft) are revolutionising the way that humans interact with AI on a regular basis. Beyond being used as personal assistants, tutors, editors and technical support, this cutting-edge AI technology can also provide new creative opportunities. Several prominent entertainment companies (Nvidia, Ubisoft, Electronic Arts, Xbox, Sony, etc.) alongside a suite of high-profile academic researchers are already exploring the potential for generative AI in video games. A popular application of this technology is to use Large Language Models (LLMs), such as those employed by the popular ChatGPT software, to generate dynamic character dialog and audio in response to a player's actions.

However, one of the limitations with these presented conversations is that they often support only one-on-one conversations between a human and AI character in a purely virtual environment. Many multiplayer and mixed-reality experiences instead require several human and AI entities to be able to easily converse with each other as a group, rather than as a strict two person only dialog. To be able to utilise existing pre-trained LLMs in these situations requires the development of a coordination framework capable of managing the flow of conversation between multiple independent entities (both human and AI).

This project will involve the research and development of a novel decision-making mechanism to manage dynamic, natural language conversations between multiple humans and AI entities in group scenarios. One potential approach for this mechanism is the creation of a higher level "director" agent, powered by a OpenAI's latest GPT-4 model. This director agent is tasked with identifying which characters are the most suitable responders for any provided prompt and instructing each AI entity when it is their turn to speak. This director agent is also responsible for providing important conversation summaries, reducing the risk of catastrophic forgetting or character derailments.

The research and development outputs of this work will be utilised as part of a larger project focussed on developing an immersive and interactive "escape room" style experience, intended to be held at Flinders' The Void as part of the Adelaide Fringe Festival in 2025. All students who conduct research to support this demonstration will be included as co-authors and/or acknowledgements in a future scientific journal publication.

This project will provide the following student learning experiences:
- Research into the capabilities of Large Multimodal Models (LMMs) capable of interpreting both text and image inputs.
- Development skills working with the OpenAI API, including utilisation of GPT-4 models for text generation and image analysis (GPT-vision), as well as Text-to-Speech and Speech-to-Text with the Whisper model.
- Understanding a variety of modern prompt engineering techniques, including Chain-of-Thought, Self-Refine, Few-Shot prompting, and Automatic-Prompt-Engineering.

Requirements:
- A basic knowledge of Python (as covered in ENGR1721 or COMP2712) or equivalent understanding of an alternative programming language such as Java or C#.

SUPERVISOR DETAILS

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PROJECT:
Playing Codenames with Large Language Models

Codenames is one of the most popular board games in the world, currently being the eighth most rated game on popular website Board Game Geek. It is a cooperative team-based game of language understanding and communication, where players must work together to discern relationships between words based on clues given by their teammates. To play successfully, players need to be able to give and interpret semantic clues for a wide range of potential teammates, requiring both a multi-modal understanding of language and epistemic reasoning (theory-of-mind). This open-ended style of play makes the task of developing adaptive agents that can modify their strategies to suit a wide range of potential teammates very difficult using traditional game-playing AI techniques.

The recent rise of large language models (LLMs) over the past few years may provide a potential solution to this challenge, having previously demonstrated their potential and flexibility in natural language understanding across many domains. This project will explore the capabilities of Large Language Models, including popular pre-trained models such as ChatGPT / GPT-4, Gemini, Claude and Llama, for playing Codenames against a variety of opponents playstyles. This will involve researching and implementing a variety of prompt engineering techniques, intended to improve the performance of the models. Investigating the impact of various prompting techniques on performance is more accessible to novice programmers, as it primarily involves using natural language without the need to train new models. The focus of this project will not only be on developing an effective Codenames player using LLMs, but also on adapting the clues and playstyles of the LLM agent to suit a wide range of teammate skill levels and playstyles.

This project will provide the following student learning experiences:
- Research into the capabilities of Large Language Models (LLMs) capable of reasoning about and generating text-based prompts.
- Development skills working with the OpenAI API for GPT-4, along with the opportunity to explore other popular LLM models such as Gemini (Google), Claude (Anthropic) and Llama (Meta).
- Understanding a variety of modern prompt engineering techniques, including Chain-of-Thought, Self-Refine, Few-Shot prompting, and Automatic-Prompt-Engineering.

Requirements:
- A basic knowledge of Python (as covered in ENGR1721 or COMP2712) or equivalent understanding of an alternative programming language such as Java or C#.

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PROJECT:
Robotic Exoskeleton Biomechanics and Control

Lower limb robotic exoskeletons offer a means of delivering fundamental principles of gait rehabilitation such a task relevant repetition and therapy intensity to users. A major consideration in the use of exoskeletons is how they are controlled and how they align with the wearer; rigid joints that only assist in one degree of freedom limit the applicability of these devices in many environments and the control strategies that can be used.

This project will see a student learn about exoskeleton structures and human biomechanics and the fundamental control strategies employed in lower limb robotics and explore designs and mechanisms that enable more natural movement by a wearer. The student(s) will get the opportunity to implement designs on Flinders University's robotic lower limb exoskeleton. It is expected that a student will build familiarity of the exoskeleton market, human biomechanics and exoskeleton mechanics and the controllers/control systems that exoskeletons employ. They will gain practical knowledge on the application of these concepts and it is expected these learnings will provide foundational knowledge in the areas mechanical and biomedical engineering and control theory; all having research currency.

A maximum of two students can be supported by this project, one for the mechanical design and biomechanics and the other for control, and the preferred project duration is 6 weeks.

SUPERVISOR DETAILS

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PROJECT:
Study and develop marine antibiofouling coatings

Fouling (the growth of marine organisms) onto ships is a serious problem that dramatically increase fuel costs, loss of maneuverability, damage and spreading of invasive species. To overcome this problem the current method uses biocides such as copper compounds in the antifouling paint. The problem with this method is that it increases the level of copper in harbors and marinas. High copper level in the water is a serious environmental concern, and such coatings are now banned in different parts of the world.

The focus of this project is to study and develop new coatings that can be used to prevent the growth of unwanted marine organisms onto different surfaces, for example ship hulls. This research is performed in collaboration with the defence industry in South Australia and is supported by the Australian Research Council.

SUPERVISOR DETAILS

Professor Mats Andersson
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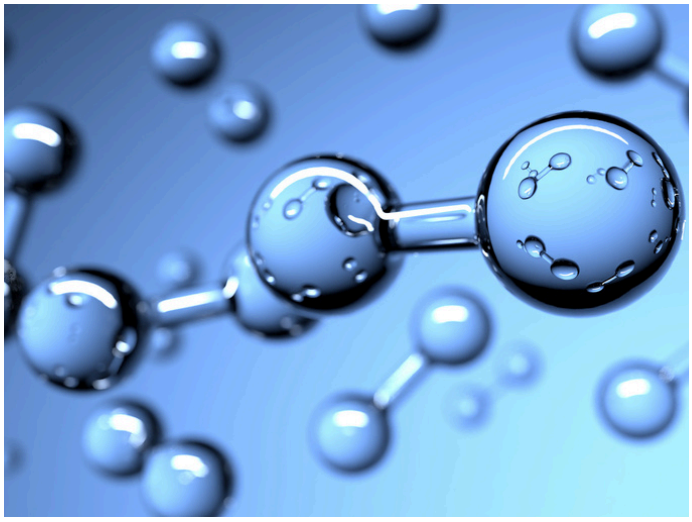
PROJECT:
Single atom catalysts for hydrogen generation

Hydrogen is considered to be one of the most important energy carriers of the future. In the transition from fossil fuel the hydrogen economy has been predicted to be one of the most viable alternatives. When generating hydrogen by water splitting using renewable energy sources such as wind and solar power low-cost catalysts are needed in the electrochemical water splitting process. Direct photocatalytic water splitting is another method that needs efficient and low-cost catalysts. In this project singe atom catalysts will be prepared and evaluated in the water splitting process.

Suitable background: Chemistry



SUPERVISOR DETAILS

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PROJECT:
Phytoplankton communities of the Coorong Wetland

The Coorong wetland faces potential significant changes that will impact its ecological dynamics, due to climate change. Two scenarios have been identified to reflect these changes and depict the following ecological conditions: (1) minimal inflows causing decreased water levels, salinity increase, algal blooms, habitat loss, and reduced fish and waterbird diversity; and (2) sea-level rise dominance leading to stable water levels, varied salinity, and shifts in habitat and fish communities.

Both scenarios highlight changes in salinity and water levels. Fluctuating salinity is one of the major natural stress factors for aquatic life in coastal waters, estuaries, brackish environments and hypersaline water bodies. Salinity and nutrients seem to drive phytoplankton community structure; in the Coorong, diatoms dominate under high/hyper salinity while chlorophytes and cyanobacteria dominate when freshwater inflow occurs. A community shift towards cyanobacteria usually induces toxin production, altered food webs and a higher risk of hypoxia.

Harmful taxa have been observed under certain conditions in the Coorong, including during the 2022-23 flood event, and it is unknown how the identified scenarios of change will impact the structure of the phytoplankton community, including the occurrence of cyanobacteria and harmful algae in the Coorong.

This project will investigate the presence of harmful algae communities during drought and flood events in the Coorong, and their potential impact on the environment and its biota.

SUPERVISOR DETAILS

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PROJECT:
Biofouling of maritime vessels – a biosecurity issue

In the ocean, barnacles, mussels, seaweed and other organisms can attach and accumulate on submerged maritime structures. This process is called biofouling and has significant impact on the sustainment of these structures and on the environment.

Biofouling can cause reduced flow rates in pipes, increased drag on boats, and damage structures such as offshore platforms. It can also lead to biosecurity concerns through the transfer of invasive species. Biofouling is often difficult to control

Understanding the formation of biofilms on submerged maritime structures is critical in developing effective strategies to prevent and control it. Currently, the most common approach is to apply antifouling coatings, which contain biocides that prevent the attachment of marine organisms to surfaces. Regular cleaning and maintenance is also critical for managing biofouling.

This project will give you an opportunity to learn about biofouling issues in the marine environment.

SUPERVISOR DETAILS

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PROJECT:
Oyster Grading Software System

Oyster grading is a crucial task for oyster farmers, and performing it manually is time-consuming. To remain profitable and maximize returns on each harvest, automating the grading process is essential. This project involves designing and developing software for a locally developed G5 grader system, which is equipped with four CCD (charge-coupled device) line scanners for scanning oysters. The project aims to devise a method and implement a mechanism to determine oyster volume, 3D dimensions (length, width, depth), center of mass, and principal axes.

SUPERVISOR DETAILS

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PROJECT:
Developing a workflow to optimise specimen identification in palaeontological deposits

Palaeontologists and archaeologists are often faced with masses of bones in a deposit, and need to find ways to quickly determine how many species, genera, or families of animals are present. This is often done by taking measurements that are assumed to be useful at distinguishing the animals. However, the human eye is often not good at making this decision, so that some crucial measurements can be missed. In this situation, it might be better to use a more comprehensive shape analysis - geometric morphometrics (GMM) - to visualise where the main differences are. This allows a better estimate of which measurements are most powerful to identify the diversity of a group of bones.

In this project, you will acquire 2D geometric data from the mandibles of a group of your choice (e.g. lizards, frogs, or mammals) in a deposit. You will use a workflow in R to identify the main differences of the sample. You will then use this information to devise the perfect measurements and apply those to a larger sample of unidentified bones. The aim is to understand how successful this currently under-utilised approach is in supporting the classification of bones in palaeontological deposits. No expertise in R is required for this project because we are particularly interested in understand the effort it takes an untrained person to create their own "perfect dataset"!

SUPERVISOR DETAILS

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PROJECT:
Characterising the Performance of Roof Antennas and Signal Path Losses

The objective of this summer project is to evaluate the performance of the antennas installed on the roof of our building and to characterise the losses and noise encountered by signals as they travel from the roof to the laboratory on the 4th floor. Students will be tasked with developing a comprehensive understanding of the factors influencing signal quality and quantifying these effects through the use of a well-defined evaluation metric.

Throughout the project, students will collect data using network analysers, spectrum analysers, and other relevant equipment. The collected data will be analysed to identify trends and correlations between signal quality and the various factors identified. The findings will then be compiled into a detailed report, which will include recommendations for improving signal performance.

SUPERVISOR DETAILS

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Scan the QR code to know more about our College Research areas.