College of Science and Engineering
Summer Research Award

Project Booklet
2023 – 2024

An Introduction to the College of Science and Engineering

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.

Our 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:

Data and Information Systems

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 contribution 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.

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.

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.

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.

Summer Research Award Projects

Nano clusters for fabrication of solar fuels

Supervisor:
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Project Summary:
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).

Basic knowledge in Physics or Chemistry (first year level) would be expected.

Ions at liquid surfaces

Supervisor:
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Phone: 8201 2309

Project Summary:
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.

Basic knowledge in Physics or Chemistry (first year level) would be expected.

Study and develop marine antibiofouling coatings

<u>Supervisor:</u>
Prof. Mats Andersson
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<u>Project Summary:</u>
Fouling (the growth of marine organisms) onto ships is a serious problem that dramatically increase fuel costs, loss of manoeuvrability, 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.

Fabricating flexible polymer solar cells

Supervisor:

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Project Summary:

Polymer solar cells have gained considerable interest during the last decades. This project is focused on optimizing printing methods for preparing polymer solar cells on flexible plastic substrates. Special emphasis will be on preparing stable and efficient solar cells using environmentally friendly fabrication processes. This project offers an opportunity to learn about conjugated polymers, how polymer solar cells works, as well as getting hands on experience with fabrication and characterization of polymer solar cells.

Suitable background: Chemistry or physics.

Aerobic performance in future climates

Supervisor:
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Project Summary:
Understanding the potential of biodiversity to respond to projected climates is a major research priority in biology. This 5-week long project is part of an ongoing research program that uses an aquatic model system to understand the vulnerability of native fauna to climate change. The primary work will involve measuring and analysing aerobic performance in present and in future climates in select populations of rainbowfish from temperate and tropical regions of Australia. The experimental work will be done at the Flinders Animal House Facility using a Loligo swimming respirometry system. The student will be trained in generating and analysing data about aerobic scope (the difference between maximum and standard metabolic rate) following established methods. Data about aerobic scope will help anchoring interpretation of thermal tolerance and gene expression data already generated for these rainbowfish populations in separate subprojects. The student will join one of Australia's most productive labs in ecological genomics of climate change, the MELFU; details at: www.molecularecology.flinders.edu.au.

Metal-organic framework composites for the recovery of precious metals

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Project Summary:

Synopsis: The accumulation of electronic waste and increasing demand for rare metals has stimulated the need to develop approaches that can recover precious metals, like gold, platinum, and palladium. This project aims to design porous materials that achieve rapid and selective capture of these precious metals while maintaining their structural integrity in water.

Background: Metal-organic Frameworks (MOFs) are an established class of ultra-porous solids that are made in one pot from organic bridging ligands and metal ions. Their tuneable pore sizes and tailorable composition make them promising candidates for a wide range of topical applications, including gas storage, catalysis, and sensing. Despite the many attractive features of this class of materials, the capture of metal-ions in aqueous media is a challenge, and necessities the presence of strong absorption sites. Lining the internal surfaces of MOFs with polymers has been shown as a promising strategy to improve the recovery % and rates of precious metals. Sulfur polymers show an excellent affinity for precious metals, but their incorporation into MOFs for precious metal recovery is an area that remains largely unexplored. This project will focus on functionalising MOFs with high-content sulfur-based polymers to provide strong absorption sites for the binding of precious metals such as gold, platinum, and palladium. Metal recovery will be performed on wastewater and solutions derived from electronic waste.

Maritime Vessel Detection and Classification

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Project Summary:
The illegal exploitation of protected marine environments has consistently threatened the biodiversity and economic development of coastal regions. Extensive monitoring in these, often remote, areas is challenging. Machine learning methods are useful in object detection and classification tasks and have the potential to underpin techniques for the development of robust monitoring systems to overcome this problem. Prior work has tested various combinations of deep convolutional neural network architectures, and preprocessing filter layers for this task (https://ieeexplore.ieee.org/document/9940921). This project will extend the past work by exploring the application of cepstrum processing; something that has been shown to be beneficial in state of the art speech processing models. The aim of the project will be to produce a classification model that is less susceptible to errors when tested against different background environmental conditions. This work has many applications in reliable autonomous acoustic detection and classification tasks far beyond the maritime domain.

Detecting clinically and environmentally relevant bacteria using OligoFlow

Supervisors:
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Project Summary:
Be part of a team working to revolutionise the future of microbiome studies. Current DNA sequencing technologies only indicate the relative proportion of specific bacterial species within a sample. This project will play a role in revolutionising microbiome studies by shifting the focus away from relative abundances to absolute quantification counts using flow cytometry. By understanding the total counts of specific bacterial species within an environment, we can understand the role of bacterial abundance profiles in fields such as wastewater management, plant and animal disease dynamics and human infection control. During this project you will learn how to use flow cytometry to detect and count clinically and environmentally relevant bacterial species using our novel OligoFlow approach.

The experimental work will be performed in the FAME laboratories within the Biological Sciences department at Flinders University (Bedford Park).

While a foundational understanding of microbiology is preferred, it is not mandatory.

Modulating lipid metabolism to promote infection resistance in patients with cystic fibrosis

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Project Summary:
Dysregulation of lipid homeostasis (i.e. dyslipidaemia) is a common cause of complications following organ transplantation. Accordingly, the use of lipid-modulating statins in the preoperative phase has shown to reduce primary graft dysfunction in the first year following lung transplantation. Cystic Fibrosis (CF) patients are common recipients of donated organs, exemplified by approximately 16% of all lung transplantations globally being performed on CF patients. CF leads to complications in various organs, but respiratory failure is the overwhelming cause of morbidity and mortality, followed by Cystic Fibrosis Liver Disease (CFLD). In addition to being the primary reasons for liver transplantation, CFLD-induced dyslipidaemia in CF patients also affects lung transplantation success. Hence, modulating lipid homeostasis in CF patients pre and post organ transplantation may lead to greater success rates, but this process is poorly understood.

CFLD primarily stems from restricted bile flow in the liver due to an increase in bile viscosity. Hepatic dyslipidaemia caused by CFLD and Fatty Liver Disease (FLD), where lipid droplet formation in hepatocytes underpin the primary pathology, can synergise disease severity in CF patients. Indeed, CFLD and FLD are common co-morbidities as a result of the high fat intake in CF patients due to elevated energy demands. These can exacerbate hepatic fibrosis and cirrhosis which are relative contraindications to lung transplantation, and compromise post lung and liver transplantation recovery.

In addition, due to the overproduction of viscous mucus in the CF lung, CF patients frequently establish chronic, antimicrobial resistant infections by *Pseudomonas aeruginosa*. To date, little is known about the impacts of chronic infection on CFLD. Alarmingly, new findings from our team have shown that hepatic lipid homeostasis is worsened by bacterial pneumonia, in a non-CF model of infection, however, a diet enriched with poly-unsaturated fatty acids has potential to counteract this form of hepatic dyslipidaemia and infection resistance, but the impact of these dietary fats on lipid homeostasis and lung physiology in CF patients with pneumonia remains unknown.

Our project will examine the central role of lipid homeostasis in CF lung and liver physiology and study the impact of host lipids *on P. aeruginosa*.

Phage therapy 101

Supervisors:

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Project Summary:

Cystic fibrosis is a genetic disorder primarily affecting sufferers' lungs and digestive systems. There is a slow lifelong progression with increasing significant bacterial infections causing difficulty breathing, higher susceptibility to lung damage, and other respiratory complications. Repeated bacterial infections and inflammation can result in permanent lung damage and decreased lung function. The condition can significantly impact a person's health and quality of life. Antibiotic treatment is crucial in managing cystic fibrosis due to chronic respiratory infections. In some patients, there is an increase in antibiotic resistance and the production of complex biofilm formation harbouring a mixture of pathogenic and non-pathogenic bacteria. Phage therapy is a new type of personalised treatment for patients suffering from this condition.

The FAME lab works with SA Pathology and other institutes to find, culture, purify, and sequence phage for use in phage therapy. During this project, you will work with a collection of clinical Stenotrophomonas, Achromobacter, Staphylococcus, and Pseudomonas bacterial species to find phages from the environment that infect and kill these bacteria. Some of those phages will be used to treat patients across Australia.
Timeline: 6 weeks
Methods - provided:
a.) Phage enrichment from environmental samples (sewage, lake water, other samples)
b.) Phage plaque double overlay
c.) Picking and isolation of phage
d.) Culturing and purifying phage
e.) Host range spot tests

Requirements:
a.) Hepatitis B vaccination - this is required of all personnel working with human sewage, and will be provided if required.
b.) IBC PC2 certificate - we will train you to use the PC2 laboratories if you have not already done so.
c.) All work to be documented in a lab book.
d.) All PC2 and WHS guidelines are to be followed while working within the laboratory.

Artificial intelligence, language and learning

Supervisor:
Dr. Richard Leibbrandt
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Project Summary:
I have a whole variety of projects available for students, all having to do with language, artificial minds, thinking or perception. They include the following:

1. Grilling the AI: Interrogating Language Models (such as ChatGPT) to examine the real limits of their knowledge - about the world, about people, about truth and logic.

2. Generative Fiction: creating new kinds of interactive story-telling experiences and tools using AI models, games, Virtual Reality, etc.

3. SpeechCAD: creating an interface for people with disabilities to operate computer software using their voice.

4. The Everything App - developing an AI-driven app to foster knowledge of Australian languages, culture and nature. This could incorporate Deep Learning visual models, speech recognition or Large Language Models.

5. Butterfly VR - programming a robot arm to record the world as viewed by a flying butterfly.

Feel free to contact me to find out more!

Characterising bacterial communities using deep learning

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Project Summary:

Metagenomics allows us to study the DNA from entire bacterial communities and understand how they impact human health and environmental sustainability. Given a mixture of DNA, how can we determine what bacteria are there? To answer this question, we cluster similar DNA sequences into separate bins to reconstruct bacterial genomes (as described in this YouTube video: https://www.youtube.com/watch?v=zmZvlNglAU0). We developed automated tools based on graph techniques to perform this clustering step. However, they find it challenging to handle enormous datasets as they depend on complex algorithms and traditional techniques that are challenging to implement efficiently to support parallel execution, especially on GPUs.

Deep learning-based clustering techniques offer several advantages and utilities in bioinformatics applications and outperform traditional clustering techniques in accuracy and efficiency. During this project, you will evaluate different graph-based deep learning techniques to process and cluster graph-structured sequence data.

We only require that you have basic Python programming experience, but it would be advantageous if you are familiar with deep learning.

The distribution of viruses, bacteria and microalgae in wastewater

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Project Summary:
Wastewater is a complex microbial mixture. How they breakdown and purify waste is still unclear. In this project the variability of the community will be quantified using flow cytometry at a variety of scales. The goals are twofold. First, investigating the population spatial variability to understand how well regular monitoring represents the overall community. Second, how the relative abundances of microbial groups change to indicate the presence of viral, bacterial and microalgal blooms.

Microplastic and nanoplastic variability in wastewater, animals and the environment

Supervisor:
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Project Summary:
Microplastics are ubiquitous in the environment. Nanoplastics are similarly ubiquitous but little studied despite being the most dangerous of the plastics because they can enter cells. We have developed methods to accurately quantify micro- and nanoplastics down to 50 nm. There are a variety of projects available to summer students. These projects include: the impact of plastics on shrimp, the distribution in wastewater, their presence in wetlands, reservoirs and the ocean, and their destruction in mechanical and biological systems.

Synthesizing peptides from amino acids via vortex fluidic device shear

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Project Summary:
For 70 years, scientists have understood that amino acids, the fundamental building blocks of life, can be and were originally formed through abiotic processes at the origin of life. The next step, making proteins abiotically, has still not been realised. The summer project is a high risk but high payoff extension of that research that will use the high shear and pressure in a vortex fluidic device to mimic the conditions at hydrothermal vents, where life is now believed to have originated. The project will start with amino acids and then look for peptide production. If successful, there is opportunity to extend this to Honours and PhD projects as well as generating high impact publications.

Applications of dinuclear gold-N-heterocyclic carbene complexes in electrophotocatalysis

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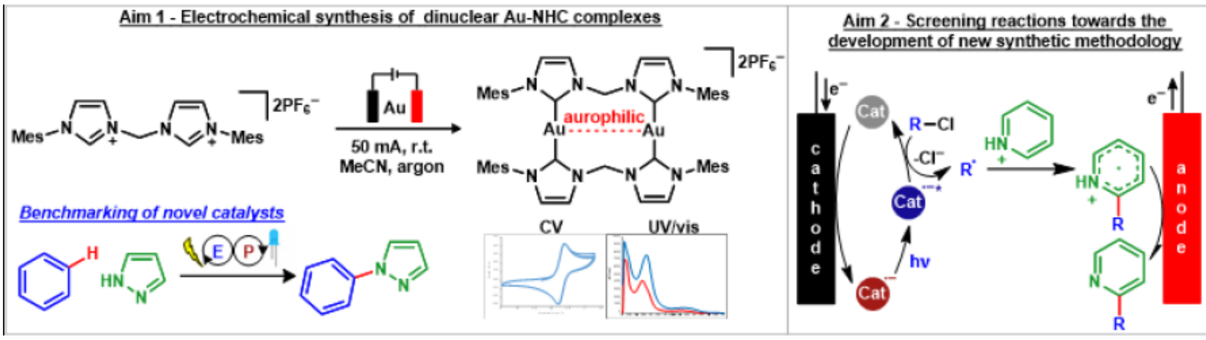
Project Summary:
Dinuclear gold-N-heterocyclic carbene (Au-NHC) complexes have found applications in photoredox catalysis including C–H activation (Aim 1). It is thought that an aurophilic interaction between the two gold centres stabilises on-cycle species which allows these complexes to be catalytically active whereas their mononuclear analogues are inactive in photoredox catalysis. It is expected that these complexes can also be activated by the combination of electricity and visible light (Aim 2). This activation mode is milder and more selective which will allow new, complex molecules to be synthesised in a single step.

An electrochemical procedure will be used to synthesise dinuclear Au-NHC complexes. Extensive characterisation of these complexes will be undertaken to determine their viability as electrophotocatalysts. Benchmarking reactions will be performed so that the efficacy of these novel catalysts can be compared to known electrophotocatalysts. Finally, screening reactions will be performed to find viable opportunities to develop new synthetic methodology.



Brain event-related potentials data collection and signal analysis

Supervisors:
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Bek O'Loughlin
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Project Summary:

EEG is a commonly used modality for understanding how the brain works. It has significant advantages in terms of ease of data collection and in the time resolution that can be achieved. Different stimuli and tasks cause a range of different characteristic voltages (potentials) to appear in the EEG data, some of which are called event related potentials (ERP). ERPs are the potentials seen in EEG following the occurrence of a specific sense-based stimulus. This project is designed to provide a student with a strong interest in neuroscience and signal analysis the opportunity to learn about EEG ERP data collection and signal analysis. This would be of significant benefit as preparation for a student who is interested in undertaking an honours project in this area.

The activities would involve:

1. Learning about EEG data collection and gaining experience in the processes.
2. Learning about standard procedures for handling and cleaning EEG data.
3. Experimenting with different protocol designs to record different ERPs.
4. Correlating their ERP findings with the current physiological understanding of the brain.

EEG data collection and signal analysis

Supervisor:

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Project Summary:

EEG is a commonly used modality for understanding how the brain works. It has significant advantages in terms of ease of data collection and in the time resolution that can be achieved. However, the collected data is very noisy. There are many standard techniques that are used to clean EEG data, some with complicated mathematical foundations. This project is designed to provide a student with a strong interest in neuroscience and signal analysis the opportunity to learn about EEG data collection and signal analysis. This would be of significant benefit as preparation for a student who is interested in undertaking an honours project in this area.

The activities would involve:

1. Learning about EEG data collection and gaining some experience in the processes.
2. Learning about standard procedures for handling and cleaning EEG data.
3. Learning about the world-leading data cleaning processes we use at Flinders.
4. Learning about standard analysis techniques and experimental designs for understanding the brain.

Thin film microfluidics - fundamental discovery of fluid flow and applications

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Project Summary:

We have developed a thin film microfluidic platform with applications in chemical synthesis, biochemistry, materials science, forensics, drug delivery, gene therapy, energy, food processing, rapid Covid-19 biomarker testing, and more. These applications have resulted in spin out companies, and industry funded projects as part of the ARC Centre of Green Chemistry Manufacturing. The fluid flow in this vortex fluidic device (VFD) is complex, arising from induced mechanical energy in a thin film (≥200 microns thick) in an inclined rapidly rotating tube, and understanding this is important in further advancing the applications. This aligns with a grand challenge in science, in understanding fluid flow. We have recently made a number of breakthroughs for VFD processing, including determining the sub-micron dimensions and topology of the fluid flow, making optically active materials, and how the Earth's magnetic field impacts on the chemistry. These contribute to predicting the flow parameters for a particular application. The research will focus on VFD fundamentals, including magnetic field effects, and/or applications to suite the interests of the awardee.

Machine learning on the semantic knife-edge: Exploring the impact of part-whole relations in scene graph generation for downstream computer vision tasks

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Project Summary:
Introduction: Recent advancements in deep learning for scene understanding and visual relationship detection in computer vision have exhibited remarkable performance. The recognition of visual relationships in images, termed Scene Graph Generation (SGG), involves describing relationships between entities within a scene as a graph comprising <subject, predicate, object> triplets. Current SGG approaches predominantly rely on the Visual Genome dataset as a benchmark for evaluating their results. However, this dataset encompasses all types of relations, including topologic, functional, attributive, and part-whole relations, all combined. The primary focus of this research proposal is to assess the significance of different relation types, particularly part-whole relations, in the learning process of SGG models and their potential utility in downstream tasks.

Research Question: In this project, we aim to investigate the role of different relation types in SGG models and explore the specific impact of part-whole relations, which are inherently invariant, on the representation learning for downstream tasks. We seek to address the following research question: "How do different types of relations, particularly part-whole relations, contribute to the learning of Scene Graph Generation models and their applicability in downstream tasks such as Visual Question Answering, Image Captioning, or Image Generation from scene graphs?"

Methodology: To answer the research question, we propose the following methodology:
1. Data Collection: We will obtain state-of-the-art Scene Graph Generation models and collect relevant datasets suitable for our evaluation, ensuring a diverse set of images with annotated scene graphs that encompass various relation types, including part-whole relations.
2. Model Selection: We will choose multiple state-of-the-art SGG models with different architectural designs and capabilities to ensure a comprehensive evaluation. Models will be trained on the collected datasets, focusing on part-whole relation-specific learning.
3. Evaluation Metrics: We will employ well-established evaluation metrics to quantify the performance of SGG models in the context of different relation types, with a specific emphasis on part-whole relations. Metrics such as Recall@K, Mean Average Precision (mAP), and F1 score will be used.
4. Downstream Tasks: To gauge the applicability of the learned representations, we will evaluate the selected SGG models on various downstream tasks, including Visual Question Answering, Image Captioning, and Image Generation from scene graphs. The objective is to determine the impact of part-whole relations on enhancing the performance of these tasks.
5. Comparative Analysis: Through a comparative analysis of the results obtained from different SGG models and their performance in downstream tasks, we will elucidate the role of part-whole relations in representation learning and their significance in practical applications.

Controllers for lower limb robotic exoskeletons

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Project Summary:
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; there are numerous control strategies each with their own advantages and challenges. This project will see a student learn about the fundamental control strategies employed in lower limb robotics and explore and implement a control strategy on Flinders University's robotic lower limb exoskeleton. It is expected that a student will build familiarity of the exoskeleton market and the controllers/control systems they employ and will gain practical knowledge on the application of these concepts. It is expected these learnings will provide foundational knowledge in the areas of human bio-mechanics, biomedical engineering and control theory; all having research currency. This project requires knowledge in programming using C++.

Groundwater experiments - effects of tides and seawater on coastal aquifers

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Project Summary:
Fresh groundwater stored in coastal aquifers is widely used to meet the demands of urban, agricultural, and industrial activities, and plays a critical role in the health of marine ecosystems through submarine freshwater discharge to the sea. Coastal groundwater resources are vulnerable to seawater intrusion (SWI); the landward incursion of seawater into coastal aquifers, resulting in reduced fresh groundwater. Critical knowledge gaps remain that limit the creation of sustainable groundwater management practices for coastal regions, particularly, the effects of tides on SWI processes remains largely unclear. This project aims to address critical knowledge gaps in the understanding of SWI within tide-affected aquifers, using physical experiments. Further details can be found in Werner et al. (2013) through this link http://dx.doi.org/10.1016/j.advwatres.2012.03.004

This summer research activity will contribute significantly to our understanding of freshwater resources in coastal systems and is appropriate for undergraduate students. The students will be based at Flinders University and will assist with the laboratory experimental work in our lab (located at Room 106A - Earth Sciences Building).

Using water chemistry to assess groundwater processes in a coastal aquifer

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Project Summary:
This summer project forms part of a large Australian Research Council-funded project on the coastal aquifers of the Lower Burdekin Delta (LBD), Queensland. The student will explore a large water chemistry dataset from groundwater sampling in the LBD, looking for trends, salinity processes and the distribution of water types, while learning new skills in mapping, hydrogeology, and hydrochemistry. The project will inform important questions around the health and vulnerability of the fresh groundwater system of the LBD that is heavily relied upon by sugarcane irrigators of the region.

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.

Preventing hospital acquired infections

Supervisors:
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Claire Hayward
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Project Summary:
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 included blood, lung (pneumonia) and skin infections. It is predominately found in wet areas within a hospital 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 various strains of *P. aeruginosa* biofilms. This information will inform infection control guidelines to reduce healthcare and hospital acquired infection.

Controlling fungal biofilms

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Project Summary:
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.

Innovative manufacturing research for advanced vertical axis wind turbines (VAWT)

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Project Summary:

Relevant background:
VAWT-X Energy, are an innovative start-up with a vision to revolutionize renewable energy generation through our patented designs for advanced vertical axis wind turbines (VAWTs). Their pioneering technology holds great promise for the future of sustainable energy, but we face a crucial challenge that requires your support.

Define problem:
While VAWT designs demonstrate exceptional performance and efficiency at the prototype level, there are challenges in their manufacturing due to the absence of a robust large-scale manufacturing process. The intricate and custom-built components, integral to achieving optimal performance standards, demand precise advanced manufacturing techniques that are currently lacking in VAWT production methodology.

Project Aim and Objectives:
A documented process for the highly automated design and manufacture of key wind turbine components that, without compromising performance or strength, maximises the use of advanced materials and satisfies the following three primary objectives:
a) Minimization of Unit Cost of Manufacture
b) Reduction of Production Time per Unit
c) Decrease Overall Turbine Weight

Deliverables:
• Successful application of identified materials and techniques to specific turbine components, with documented performance and cost improvements.
• Recommendations for design modifications, if required, to achieve the project's objectives.