Science Summer Research: Denison & Science Research Experience Scholarships

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Chemistry

Project: (CHEM1) Role of Orientation in Molecular Crystallization
Scholar will use computer simulations of molecular crystallization to explore the role of rotational kinetics on the rate of crystal growth. No prior experience in simulations is required. The project provides an excellent introduction to simulation methods.

Dates: Flexible but Feb-Mar optimal none (although an interest in computational methods is helpful)
Pre-requisite:

Project: (CHEM 2) Computer simulation of next-generation solar cells
New technologies promise next-generation solar cells that are cheaper, more flexible, and more efficient than current ones. However, many elementary processes occurring in these solar cells are poorly understood, and your project will be to write and use computer programs to simulate how they work at the fundamental level. Options include studying organic solar cells and hybrid organic-inorganic perovskite solar cells.

Dates: Any
Pre-requisite: Programming experience is helpful, but not required.
Supervisor: Dr Ivan Kassal - ivan.kassal@sydney.edu.au - www.kassal.group

Project: (CHEM3) Synthesis and Evaluation of Fluorescent Macrocycles for Anion Recognition
Anions are ubiquitous in nature, playing crucial roles in both biological and industrial processes. There is therefore, a real need to develop tools to monitor anions in our environment. The aim of this project is to synthesise and evaluate fluorescent macrocyclic receptors for the selective detection of specific anions. These receptors will have applications in biomedical and environmental research.

Dates: Jan-Feb
Pre-requisite:

Project: (CHEM4) Natural engineered nanostructures
In this project the summer scholar will study natural surfaces that have special wettability, for example they are superhydrophobic or slippery. The experiment will combine experimental procedures already established in the Neto group and the literature with elements of advanced research to stimulate the public's interest in nanoscience.

Dates: Any
Pre-requisite: Knowledge of second year chemistry
**Project: (CHEM5) New biocompatible reactions for protein modification**

Site-specific modification of proteins is an important technique for drug development, and a major challenge for synthetic chemists. This is a question of chemoselectivity: how can we perform a reaction at a chosen functional group, without affecting the hundred other unprotected groups that exist on a protein? In this project, we will develop new synthetic reagents and methods for modifying proteins.

Dates: Feb-Mar

Pre-requisite:


**Project: (CHEM6) Self-assembling nanocompartments for catalysis and drug delivery**

Nature is a master of self-assembly, constructing incredible nanoscale architectures from simple building blocks. One example of self-assembly is the “encapsulin” family of proteins, which can spontaneously form hollow 30 nm compartments. This project will involve re-engineering encapsulins, converting them into catalytic nanoreactors and vessels for drug delivery.

Dates: Feb-Mar

Pre-requisite:


**Project: (CHEM7) Effects of Hypoxia of the Efficacy of Metal Anti-Cancer Drugs**

This research will examine the effects of metal-anticancer drugs on cancer cells under normoxic (ambient oxygen levels) and hypoxia (low oxygen levels) that are encountered by different populations of cancer cells in a tumour. In particular, we will investigate the cytotoxicity and anti-metastatic properties of the drugs under these two different conditions. It is important that we are able to understand and control these anti-cancer efficacies against cancer cells in both environments in order to obtain optimal treatments. Also considered will be the effects of pH values on these biological activities over the pH range of ~6.5-7.4 where different cancer cells can be encountered.

Dates: Feb-March

Pre-requisite: Knowledge of medicinal chemistry and cell assays.


Secondary Supervisor: Dr Aviva Levina - aviva.levina@sydney.edu.au
**Project: (CHEM8) Faraday Rotation in Organic Semiconductors**
Society’s over-reliance on information exchange around the world hinges critically on ultrafast data communication using light signals. Faraday Rotation is an optical phenomenon that ensures non-reciprocal transport of light in optical fibers blocking unwanted reflection signals. This project will use a range of complementary experimental approaches to study Faraday Rotation in an emerging class of organic semiconductors.

**Dates:** Jan-Feb  
**Pre-requisite:** Distinction in CHEM2401 or CHEM3117  

**Project: (CHEM9) Device Physics of Organic Solar Cells**
p-conjugated organic materials are cheap, easily processible and flexible alternatives to silicon for sustainable energy applications like organic solar cells. In this project, you will perform numerical simulations using Matlab to probe the device function of solar cells and identify design rules to reduce charge transport losses and improve device efficiencies.

**Dates:** Jan-Feb  
**Pre-requisite:** "Distinction in CHEM2401 or CHEM3117. Familiarity with Matlab."

**Project: (CHEM10) Polariton Lasing**
Unlike conventional lasing that requires population inversion of electrons (fermions), polaritons are boson-like particles that would allow lasing at relatively low pump thresholds. In this project, you will simulate device function of GaN polariton laser and identify design rules that can be applied to organic counterparts. The results of this project will also inform industry of strategies for low power driven electronics.

**Dates:** Jan-Feb  
**Pre-requisite:** Distinction in CHEM2401 or CHEM3117  

**Project: (CHEM11) Phase behaviour of Janus rods and helices**
Nanoparticles can now be made that have surfaces with two distinct physical properties. Such Janus particles can exhibit complex phase behaviour ranging from small micelle-like clusters to sheets and twisted assemblies. This provides a scalable way to assemble complex nanostructured materials with unique properties. In this project, you will use computer simulations to investigate the phase behaviour of Janus rods and helices, which will allow you to discover how their phase behaviour differs from those of Janus spheres, hard rods and hard helices.

**Dates:** Any  
**Pre-requisites:**  
**Project: (CHEM12) Using light to make polymers**
We will use light to facilitate polymerisation. Your investigations will be used to develop a new photoreactor and study the formation of polymers under various light conditions. We will use some of the data generated to develop new polymer experiments.

Dates: Jan-Mar 2019
Pre-requisites: passed CHEM2 and/or CHEM3 subjects

**Project: (CHEM13) Synthetic bottlebrush polymers**
We will use controlled polymerisation methods to produce new polymers shaped like the Australian bottlebrush plant (only 1000 times smaller). Polymer architectures like these find applications in nanomedicine and can be used as nanoreactors.

Dates: Jan-Mar 2019
Pre-requisites: passed CHEM2 and/or CHEM3 subjects

**Project: (CHEM14) Functional characterisation of mutated Na+,K+-ATPase related to disease states**
The ion pumping activity of the Na+,K+-ATPase is vital to the survival of all animal cells. Mutations in the protein’s catalytic subunit has been shown to cause a number of hereditary diseases, particularly nerve disorders, e.g. rapid-onset dystonia Parkinsonism. The aim of this project is to investigate the molecular basis of the effect of some mutations on Na+,K+-ATPase function.

Dates: Dec-Jan OR Jan-Feb (depending on the student’s availability)
Pre-requisites:

**Project: (CHEM15) Hierarchical assembly of DNA origami**
To physical and chemical scientists, DNA also has huge potential as a programmable building material for biocompatible nanostructures, which can be self-assembled from the bottom up. This project aims to take inspiration from biological systems and use hierarchical assembly to combine many DNA origami nanostructures into a larger assembly. Projects will generally involve some combination of: computer aided design and modelling of DNA origami, assembly of structures and analysis with advanced imaging techniques, such as transmission electron microscopy (TEM), atomic force microscopy (AFM).

Dates: Jan-Feb, Feb-Mar
Pre-requisites:

**Project: (CHEM16) DNA nanostructures to target bacteria**
DNA can be used to make self-assembling nanoscale structures and devices - with almost any shape we want - using a method called DNA origami. In our group, we are designing a DNA origami nanorobot that selectively destroys microbes, to address the global challenge of antimicrobial
resistance. This goal is divided into three sections; targeting, signalling and destruction. This summer project focuses on targeting lipid-binding DNA origami structures to specific microbes. It will involve designing and testing DNA aptamers, which are specific DNA sequences that can selectively bind to a particular surface ligand on a microbe.

Dates: Jan-Feb, Feb-Mar

Pre-requisites:

**Project: (CHEM17) Sensing arrays to measure therapeutic drug levels in the blood.**

Platinum-based drugs are used in a large proportion of all chemotherapy regimens, but methods to measure drug levels in the blood are still lacking. This project will involve testing a new fluorescent sensing array for measuring platinum levels in the blood, which can be applied to chemotherapy patients as well as to understanding the mode of action of cisplatin-based drugs.

Dates: Jan-Feb or Feb-Mar

Pre-requisites: CHEM2401/2911/2915 AND CHEM2402/2912/2916


**Project: (CHEM18) New fluorescent sensors for imaging cells**

Fluorescence microscopy techniques enable us to visualise the complex chemical processes that take place within cells and tissue. In order to study sub-cellular processes, we need to be able to image organelles within cells. This project will involve synthesis of new fluorescence sensors that are targeted to sub-cellular organelles.

Dates: Jan-Feb or Feb-Mar

Pre-requisites: CHEM2401/2911/2915 AND CHEM2402/2912/2916


**Project: (CHEM19) Supramolecular Channels Toward Non-Equilibrium Transmembrane Ion Transport**

In Nature, transmembrane proteins maintain ion homeostasis in living systems and create biochemical gradients via active ion pumping processes. Here, we seek to utilise supramolecular interactions based on metal-coordination chemistry to build well-defined channels spanning across the lipid bilayer membrane to facilitate transmembrane ion transport. We aim to build channels which can be precisely modulated to facilitate active ion transport against concentration gradient (a non-equilibrium process) mimicking that of an ion active pump.

Dates: Nov-Dec OR Dec-Jan OR Jan-Feb

Pre-requisites:

**Project: (CHEM20) Collisional Stabilisation of Atmospheric Molecules**

This project will model the collisional stabilisation of a molecule that has absorbed a photon in the atmosphere. The competition between stabilisation and reaction to form radicals plays an integral part
in determining overall atmospheric chemistry. We know almost nothing, however, about the nature or efficiency of collisional stabilisation. You will use computational models and classical dynamics to investigate this process and its dependence on initial energy and molecular structure.

Dates: Jan-Feb OR Feb-Mar
Pre-requisites:

**Project: (CHEM21) Targeting high value chemicals through nickel catalysis using natural oil feedstocks**
As fossil fuels resources continue to be consumed, it’s ever more important to provide alternative routes to provide speciality chemicals using sustainable natural resources, such as natural or essential oils. Often chemicals from these origins tend to be less toxic and more biodegradable than the petrochemical alternative. From a feedstock of a natural oil, this project intends to produce important chemicals used today as attractants for the tsetse fly to stop the spread of disease in Africa. This project will also explore the use of nickel chlorides as a much cheaper metal than palladium or platinum catalysts in the production of these key chemicals.

Dates: Feb-Mar
Pre-requisites:
Physics

Project: (PHYS1) Novel fibre based biomedical sensors
We have developed a novel type of fibre based on polyurethane that can contain optical waveguides and/or electrodes. It is very readily deformed or stretched, and this mechanical perturbation translates to detectable changes of optical or electrical signals. This opens up a wide range of potential applications, particularly in biomedicine, such as monitoring pulse, respiration or movement. There are also potential applications in wearables and robotics. The project will explore one of these applications, aiming to build a proof of concept demonstrator.

Dates: Dec-Jan; Jan-Feb; Feb-Mar;

Pre-requisites:
Supervisor: Prof Simon Fleming - simon.fleming@sydney.edu.au
Secondary Supervisor: Prof Maryanne Large - maryanne.large@sydney.edu.au

Project: (PHYS2) Physics Quantum Control with Trapped Ions
Quantum technology, harnessing quantum physics as a resource, will be as transformational in the 21st century as harnessing electricity was in the 19th. The Quantum Control Lab is addressing some of the hardest problems in quantum technology, with a special focus on how control engineering can allow systems which obey the laws of quantum physics to perform useful tasks. Students in our lab learn to control and manipulate real quantum systems using individual trapped ions in an effort to build true world-changing technologies. Projects are laboratory based in the Sydney Nanoscience Hub.

Nov-Dec; Dec-Jan; Jan-Feb; Feb-Mar; Prof Michael J. Biercuk
michael.biercuk@sydney.edu.au

Project: (PHYS3) Physics Measuring oscillating stars using NASA’s Kepler mission
"The new field of ‘asteroseismology’ (=starquakes) involves using the oscillation frequencies of a star to measure its internal properties. Many stars, including the Sun, are observed to oscillate. This project will use data from NASA’s Kepler Mission, which is a 1-metre space telescope that has discovered thousands of planets transiting other stars, and is also perfect for studying stellar oscillations. We can probe their internal structure, measuring age and internal rotation.

Date: Nov-Dec; Dec-Jan; Jan-Feb; Feb-Mar;

Pre-requisite:
Supervisor: Prof Tim Bedding - tim.bedding@sydney.edu.au

Project: (PHYS4) Pulse formation in dysprosium fibre lasers
The formation of short light pulses in lasers is important, since many applications require high intensities for short lengths of time. Mode-locking, the conventional method to achieve this, works by locking the phases of the linear laser modes together, so they interfere constructively periodically. Recently developed infrared dysprosium lasers do emit short pulses, but they do not have modes, and the conventional process thus cannot possibly work. The aim of this computational project is to investigate how come these lasers nonetheless manage to emit pulses.

Dates: Nov-Dec; Dec-Jan; Jan-Feb;
Pre-requisites:

Secondary Supervisor: Dr Rob Woodward (Macquarie University)

Project: (PHYS5) fMRI biomarkers of Schizophrenia
The student will discover the brain locations and features of fMRI dynamics that best diagnose patients with schizophrenia. The student should have a strong interest in coding, machine learning, and data science.

Dates: Nov-Dec;Dec-Jan;Jan-Feb;Feb-Mar;

Pre-requisites:

Supervisor: Dr Ben Fulcher - ben.fulcher@sydney.edu.au - www.benfulcher.com

Project: (PHYS6) The Power of Quantum Computing
What gives quantum computers their power? We don't have a good answer to this question. One approach to answering it involves developing (classical) simulation methods for quantum processes. If we can efficiently simulate a quantum circuit on a classical computer, then clearly it's not 'quantum powerful'. This theory project will involve coding up a new approach to simulating quantum circuits by using 'negative probabilities', and testing how well these simulations run, with a goal of isolating the key quantum resources.

Dates: Nov-Dec; Jan-Feb; Feb-Mar;

Pre-requisites:

Supervisor: Prof Stephen Bartlett - stephen.bartlett@sydney.edu.au
http://sydney.edu.au/science/people/stephen.bartlett

Project: (PHYS7) Exotic Quantum Many-Body Systems for Quantum Computing
Quantum computers are potentially much more powerful than the computers we use today, but building a quantum computer is a huge challenge. Most proposals to construct one involve building it from scratch "atom by atom". What we have shown is that certain materials, when cooled down to a very low temperature, will naturally form a quantum computer on their own. This way, we may be able to get nature to build our quantum computers for us: we just have to find (or synthesize) the right material, then put it in the fridge. This theory project will be to investigate the zero- and low-temperature quantum phases of some promising spin lattices, and develop techniques for quantum computation that are robust against variations in the Hamiltonian, thermal errors, or other deleterious effects.

Dates: Nov-Dec; Jan-Feb; Feb-Mar;

Pre-requisites:

Supervisor: Prof Stephen Bartlett - stephen.bartlett@sydney.edu.au
http://sydney.edu.au/science/people/stephen.bartlett

Project: (PHYS8) Emulating brain-like features from a neuromorphic AI nanotechnology device
This project aims to emulate brain-like synaptic plasticity features from a unique nano-electronic device, an atomic switch network, with synthetic synapses in a neural network-like structure. The project
involves computational modelling of the experimental device using Matlab to explore the neuromorphic network’s response to a range of different electrical stimuli. Ultimately, the modelling results will inform the development of an artificial intelligence (AI) hardware device for “thinking machines”.

Date: Nov-Dec; Feb-Mar;

Pre-requisites:
Supervisor: Prof Zdenka Kuncic - zdenka.kuncic@sydney.edu.au

**Project: (PHYS9) Quantum Nanophotonics: the platform for the next generation of quantum information processing**
Quantum Nanophotonic devices currently use linear integrated photonics to solve quantum mechanical algorithms. However, these chips need a very bright, pure and on demand source of single photons. The aim of this project is to explore with preliminary measurements novel nanophotonics structures which could supplied such sources for the next generation of quantum information processors. This work will be performed in in the Nanophotonics and Plasmonics Advancement Lab (NPAL), part of the Institute of Photonics and Optical Science (IPOS).

Dates: Nov-Dec;Dec-Jan;Jan-Feb;Feb-Mar;

Pre-requisites:

**Project: (PHYS10) Gadolinium nanoparticles for improved radiotherapy with real-time tracking on the Australian MRI-Linac**
"Radiotherapy treatment uses high energy photons to ionise molecules in the body causing biological damage which, when targeted on a tumour, delivers an effective anti-cancer therapy. It has recently been shown that nanoparticles made of a high atomic number material increase low-energy ionisations and enhance the biological damage caused during a radiotherapy treatment. Choosing gadolinium as the nanoparticle material enables the nanoparticles to be tracked with MRI, which can be done in real-time during radiation treatment on new dual MRI-linac machines like the Australian MRI-linac in Liverpool.

This project aims to quantify the increased energy deposition in a sample of nanoparticle solution compared to pure water using micro-sized silicon-based detectors. Simple computer simulations will be used to refine the protocol design. Experiments will be done out-of-hours on clinical machines at the Chris O'Brien Lifehouse and can also be run at the Australian MRI-linac in Liverpool."

Dates: Dec-Jan; Jan-Feb; Feb-Mar;

Pre-requisites:


**Project: (PHYS11) The fastest slow transition: a shortcut to adiabaticity**
Routing light between different on-chip photonic nanowires is of fundamental importance in integrated photonics. One particularly attractive method is adiabatic conversion, since it enables broadband performance with ~100% conversion efficiency. Typically, this requires the transition to be very slow,
which in many cases is not practical, since the available space on a photonic chip is limited. The aim of this project is to apply a strategy to make this transition orders of magnitudes faster, to the case of two silicon nanowires – the fundamental building block of photonic circuitry – which will subsequently be fabricated at the Sydney Nanoscience Hub.

Dates: Nov-Dec;Dec-Jan;Jan-Feb;Feb-Mar;

Pre-requisites:

Supervisor: Dr Alessandro Tuniz - alessandro.tuniz@sydney.edu.au
Secondary Supervisor: Prof Martijn de Sterke - martijn.desterke@sydney.edu.au

**Project: (PHYS12) Optical micro-resonators: a potential new route for specialized photonic devices**

Optical micro-resonators can be used as excellent sensors for lab-on-a-chip devices, integrated optical filter, optical limiters, etc. This project aims to develop an experimental optical setup capable of measuring the optical properties of such micro-resonators regardless their dimensions and material. This work will be performed in the Nanophotonics and Plasmonics Advancement Lab (NPAL), part of the Institute of Photonics and Optical Science (IPOS), in collaboration with Dr Irina Kabakova (UTS) and the Defence Science and Technology Group.

Dates: Nov-Dec;Dec-Jan;Jan-Feb;Feb-Mar;

Pre-requisites:

Supervisor: A/Prof Stefano Palomba - stefano.palomba@sydney.edu.au
Dr Irina Kabakova - Irina.Kabakova@uts.edu.au

Secondary Supervisor: Prof Martijn de Sterke - martijn.desterke@sydney.edu.au

**Project: (PHYS13) Coupled optical micro-resonators modelling for specialized photonic devices**

Optical micro-resonators can be used as excellent sensors for lab-on-a-chip devices, integrated optical filter, optical limiters, etc. This project aims to model the interactions between coupled micro-resonators and their potential applications as specialized photonics devices. This work will be performed in the Institute of Photonics and Optical Science (IPOS), in collaboration with Dr Irina Kabakova (UTS) and the Defence Science and Technology Group.

Dates: Nov-Dec;Dec-Jan;Jan-Feb;Feb-Mar;

Pre-requisites:

Supervisor: Prof Martijn de Sterke - martijn.desterke@sydney.edu.au
Dr Irina Kabakova (UTS) - Irina.Kabakova@uts.edu.au
Project: (PHYS14) Novel Nanolasers: a brighter future for photonic integrated devices
Waveguide-based nanolasers are central to classical and quantum nanophotonics. The field of nanolaser is currently experiencing an impasse since all demonstrations follow designs that have remained essentially unchanged for a decade. The project aims to experimentally test our recently discovered and fabricated novel configuration that can break this impasse. This work will be performed in the Nanophotonics and Plasmonics Advancement Lab (NPAL), part of the Institute of Photonics and Optical Science (IPOS).

Date: Nov-Dec; Dec-Jan; Jan-Feb; Feb-Mar;
Pre-requisites:
Supervisor: A/Prof Stefano Palomba - stefano.palomba@sydney.edu.au
Dr Alessandro Tuniz - alessandro.tuniz@sydney.edu.au
Prof Martijn de Sterke - martijn.desterke@sydney.edu.au

Project: (PHYS15) Nonlinear optical properties from novel organic films
The field of integrated nonlinear optics has shown so far very low conversion efficiency from nonlinear nanophotonic devices. This project aims to probe, by a z-scan setup, the nonlinear characteristic of novel organic films which could be embedded in nonlinear nanophotonic devices, augmenting their nonlinear conversion efficiency. This work will be performed in the Nanophotonics and Plasmonics Advancement Lab (NPAL), part of the Institute of Photonics and Optical Science (IPOS).

Dates: Nov-Dec; Dec-Jan; Jan-Feb; Feb-Mar;
Pre-requisites:
Supervisors: A/Prof Stefano Palomba, stefano.palomba@sydney.edu.au
Dr Alessandro Tuniz - alessandro.tuniz@sydney.edu.au
Secondary Supervisor: Prof Martijn de Sterke - martijn.desterke@sydney.edu.au

Project: (PHYS16) Detect prostate cancer lesions from imaging data using deep learning methods
Deep learning is the state-of-the-art method for computer vision. In this project, the student will develop a convolutional neural network for detecting prostate tumours from medical imaging (multiparametric MRI) data. This will be a great opportunity for someone who wants to develop skills in programming, mathematics and machine learning.

Dates: Dec-Jan; Jan-Feb; Feb-Mar;
Pre-requisites:
Supervisor: Prof Annette Haworth - annette.haworth@sydney.edu.au,
Secondary Supervisor: Yu Sun - yu.sun@sydney.edu.au
Project: (PHYS17) Galaxy evolution as environmental science
The formation and evolution of galaxies could be regarded at the ultimate environmental science. Galaxies are profoundly influenced by their surroundings, and that leads to fundamental changes in star formation and structure. Using data from the international SAMI Galaxy Survey (led from University of Sydney) we will be connecting the internal properties of galaxies to their larger-scale environment. There are a number of possible projects in this field, including: quantifying the role of super-massive black holes; discovering how galaxies grow by accreting gas; finding novel ways to connect the spin of a galaxy to its surroundings; timing the shut down of star formation. Some coding experience in a language such as python would be an advantage in most of these projects.

Dates: Nov-Dec; Jan-Feb; Feb-Mar;
Pre-requisites:
Supervisor: Prof Scott Croom - scott.croom@sydney.edu.au

Project: (PHYS18) First-principles theory and computation for design and discovery of low-dimensional materials for nanoscience applications
We have a number of projects related to ab initio simulation/computation of materials and processes for catalysis and nanoelectronics.

Dates: Jan-Feb; Feb-Mar;
Pre-requisites:
Supervisor: Prof Catherine Stampfl - catherine.stampfl@sydney.edu.au

Project: (PHYS19) First data from the Belle II experiment at KEK
Belle II is a major new particle physics experiment at the KEK laboratory in Tsukuba, Japan. The SuperKEKB collider uses electron and positron beams to produce large numbers of pairs of B mesons, bound states of a bottom quark/antiquark and a lighter antiquark/quark. The decays of these particles will be used to search for physics beyond the Standard Model of particle physics. Belle II had a brief commissioning run this year and in this project we will examine the data from that run. This will help us in planning for the first major run of the experiment which will happen in 2019, and give the project student a good taste of how experimental particle physics is carried out.

Dates: Nov-Dec; Dec-Jan; Jan-Feb;
Supervisor: Prof Kevin Varvell - kevin.varvell@sydney.edu.au
Secondary Supervisors: Dr Chia-Ling Hsu - chia-ling.hsu@sydney.edu.au

Project: (PHYS20) The TOLIMAN space telescope
"Despite the manifest success witnessed by catalogs of exoplanetary detections climbing into the thousands, contemporary astronomy is still poorly equipped to answer the basic question of whether there are any potentially temperate planets orbiting any particular star system. This problem becomes particularly acute when considering stars in our local neighbourhood: close enough for detailed follow-up missions to characterize on decades timescales, and potentially for exploration by space probe on centuries timescales."
Overwhelmingly the most promising technology to deliver a complete census of nearby habitable zone exoplanets and their properties down to Earth mass is high precision astrometry; to date a quite minor player in the exoplanetary domain. This project will help to establish the design for the TOLIMAN space telescope dedicated to astrometric detection of exoplanets, particularly targeting the Alpha Cen system. A Foundational Mission Study, jointly funded by the Breakthrough Prize Foundation and the University of Sydney, is now underway. The project will model the innovative principles underlying the detection strategy and help specify the following phases of construction and launch.

Dates: Nov-Dec;Dec-Jan;Jan-Feb;Feb-Mar;

Pre-requisites:
Supervisor: Prof Peter Tuthill - peter.tuthill@sydney.edu.au - www.physics.usyd.edu.au/~gekko

Secondary Supervisor: Dr Barnaby Norris - barnaby.norris@sydney.edu.au

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**Project: (PHYS21) The ATLAS experiment at CERN's Large Hadron Collider**
The ATLAS experiment is one of two large experiments at CERN’s Large Hadron Collider, and has been recording proton-proton collisions since 2010. The Higgs boson was discovered by these experiments in 2012, and they continue to search for physics beyond the Standard Model of particle physics. The LHC and ATLAS will undergo staged upgrades over the next few years to increase the rate at which collisions occur and are recorded, and this upgrade presents many technical challenges. In this project, we will study ways to improve the ability of the future detector to track and identify charged particles. The project student can expect to get a good insight into how experimental particle physics is carried out.

Dates: Nov-Dec; Dec-Jan; Jan-Feb;

Pre-requisites:
Supervisor: Prof Kevin Varvell - kevin.varvell@sydney.edu.au http://www.physics.usyd.edu.au/~kev/

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**Project: (PHYS22) Exoplanets with the James Webb Space Telescope**
The James Webb Space Telescope stands to inherit the mantle of the Hubble Space Telescope as the pre-eminent astronomical observatory of the 21st century. With a primary mirror more than 6 meters in diameter, this mission will fly to the L2 Lagrangian point to begin a unique mission of discovery. When it does so, it will deploy a unique interferometric imaging mode designed, built and led from the University of Sydney. This aperture masking interferometer is aboard the NIRISS instrument, and will empower the JWST to make the finest and most sensitive surveys for the presence of faint structures in the environment of forming stars that have ever been achieved. This opens an entirely new window on the origins of structure from stars to brown dwarfs to planets, informing our own origins and place in the universe as well as expectations for the ubiquity and diversity of exoplanets in the Galaxy. This project will help prepare the way for Science at the 2021 launch.

Dates: Nov-Dec; Dec-Jan; Jan-Feb; Feb-Mar;

Pre-requisites:
Supervisor: Prof Peter Tuthill - peter.tuthill@sydney.edu.au - www.physics.usyd.edu.au/~gekko
**Project: (PHYS23) How can we tell one particle from another?**

Particle physics experiments measure many different particles at a time: electrons, muons, pions, kaons, protons, and others. In our group here at Sydney, we have developed a way of isolating very pure samples of several particles --- pions, kaons, protons, and anti-protons --- at the Belle experiment in Japan. We can use these samples as a tool to find out what the different particles "look like" in the Belle detector, which will help us to identify these particles in future Belle data. In this project, you will help to find ways to distinguish these particles from each other.

Dates: Jan-Feb;

Pre-requisites:

Supervisor: A/Prof Bruce Yabsley - bruce.yabsley@sydney.edu.au

Secondary Supervisor: Dr Frank Meier - frank.meier@sydney.edu.au

**Project: (PHYS24) Biomimetic energy localisation: from trees to spider webs**

Inspired by two of the most familiar topologies from the world around us, trees and webs, in this project you will examine how the connectivity and topology of an oscillator network changes the nature of energy localisation. You will learn the language of nonlinear oscillators, and how to find these localised energy states, and seek to determine if these topologies have particular energy localising properties. This project will be primarily computational in nature, though some analytical work may also be involved.

Dates: Nov-Dec; Dec-Jan; Jan-Feb; Feb-Mar;

Pre-requisites:

Supervisor: Dr Tristram Alexander - tristram.alexander@sydney.edu.au


**Project: (PHYS25) What does it take to have a conversation on Twitter?**

The immense quantity of data capturing what people are saying has attracted a large number of researchers interested in determining the reliability of Twitter for predicting public opinion more broadly. However, the actual exchanges between Twitter users are still poorly understood. In this project you will have the opportunity to examine the nature of conversations between Twitter users, and compare the statistics extracted from the data with the predictions of a computational model. This is a computational and data analysis project and will use tools from data science, statistical physics and nonlinear physics.

Dates: Nov-Dec; Dec-Jan; Jan-Feb; Feb-Mar;

Pre-requisites:

Supervisor: Dr Tristram Alexander - tristram.alexander@sydney.edu.au


**Project: (PHYS26) Exploring solutions to gun violence**

In this project you will have the opportunity to develop and use an agent-based model, in many ways similar to models used in molecular dynamics simulations, to explore proposed solutions to gun violence. Varying system parameters such as gun density, police density and weapon lethality, statistics characterising the different approaches will be generated and compared. This is a computational project and as such you will gain experience in developing and testing a computational model, generating statistics and comparing the results with real-world data.

Dates: Nov-Dec; Dec-Jan; Jan-Feb; Feb-Mar;
Pre-requisites:

Supervisor: Dr Tristram Alexander - tristram.alexander@sydney.edu.au
History and Philosophy of Science

Project: (HPSC1) GLOBAL HEALTH: PAST, PRESENT AND FUTURE

Dates: Dec-Jan

Pre-requisites:

Supervisor: Assoc. Professor Hans Pols - hans.pols@sydney.edu.au
Mathematics and Statistics

**Project: (MATH1) Groupoids and cocycles**

A groupoid is a generalisation of a group in which there can be many identity elements, and elements only have local inverses. We will study cocycles on groupoids and how the cocycle structure interacts with the Zappa-Szep product construction for groupoids.

**Dates:** Any period

**Pre-requisites:** MATH2022/2922 and MATH2023/2923

**Supervisor:** Dr Zahra Afsar - zahra.afsar@sydney.edu.au

**Secondary Supervisor:** Dr Nathan Brownlowe - nathan.brownlowe@sydney.edu.au

**Project: (MATH2) Discovering topics in textual data**

One of the main computational and scientific challenges in the modern age is to extract useful information from unstructured texts. For instance, in order to understand social media and online social networks it is essential to quantitatively investigate the communication taking place in these systems, which happens mostly through text. The most popular tools for unsupervised extraction of information from large textual databases is topic models. In Ref. [1] we have shown how a community-detection method originated in the field of Complex Networks outperforms traditional Machine Learning methods for topic modelling. The idea of this project is to explore the textual datasets of social media using topic models (and codes) proposed in Ref. [1]: M. Gerlach, T. P. Peixoto, and E. G. Altmann, A network approach to topic models, Sci. Adv. 4, eaaq1360 (2018)

**Dates:** Feb-Mar

**Pre-requisites:** Coding (preferable python), MATH1005/1905

**Group Project:** Up to 2 students

**Supervisor:** Associate Professor Eduardo Altmann - eduardo.altmann@sydney.edu.au

**Project: (MATH3) Adoption of innovations and S-curves**

"Adoption of innovations (or opinions) has been modeled through a variety of mathematical models, many inspired by disease spreading models. The idea of this project is to compare predictions of the adoption curve from different models to real data of adoptions curves of new technologies, social behaviour, or linguistic innovations. Different models will be compared in terms based on statistical model comparison and in terms of their prediction of future evolution. Model parameters will be inferred from the data and used to compare different models, and predict the future. Specifically, the project will build on the methods developed in Ref. [1], software available in Ref. [2], and apply them to new problems and datasets. References:


Dates: Feb-Mar
Pre-requisites: Coding (preferable python), MATH1005/1905
Supervisor: Associate Professor Eduardo Altmann - eduardo.altmann@sydney.edu.au

Project: (MATH4) Sample path generation for stochastic processes
Sample path generation enables one to simulate a hitting time, and other functionals of a jump-diffusion dynamics with state-dependent drift, volatility, jump intensity, and jump size. In this project, we will explore a variety of sample path generation methods with a view towards applications, including unbiased estimation of transition densities, hitting probabilities, and many other quantities arising in jump-diffusion dynamics. Some programming experience is essential. Suitable for up to three students.
Dates: Any period
Pre-requisites: STAT3911 and MATH3969
Group project: Up to 3 students
Supervisor: Dr Ray Kawai - reiichiro.kawai@sydney.edu.au

Project: (MATH5) Research in false discoveries
The multiple testing problem arises when we wish to test many hypotheses at once. Initially people tried to control the probability that we falsely reject at least one true null hypothesis. However, in a groundbreaking paper Benjamini and Hochberg suggested that alternatively we can control the false discovery rate (FDR): the expected percentage of true null hypotheses among all the rejected hypotheses. Shortly after its introduction FDR became the preferred tool for multiple testing analysis with the original 1995 paper garnering over 47K citations. There are several related problems in the analysis of false discoveries that would be intriguing to explore.
Dates: Nov-Dec, Dec-Jan
Pre-requisites: STAT2911
Group Project: Up to 3 students
Supervisor: Associate Professor Uri Keich - uri.keich@sydney.edu.au

Project: (MATH6) FDR in mass spectrometry
In a shotgun proteomics experiment tandem mass spectrometry is used to identify the proteins in a sample. The identification begins with associating with each of the thousands of the generated peptide fragmentation spectra an optimal matching peptide among all peptides in a candidate database. Unfortunately, the resulting list of optimal peptide-spectrum matches contains many incorrect, random matches. Thus, we are faced with a formidable statistical problem of estimating the rate of false discoveries in say the top 1000 matches from that list. The problem gets even more complicated when we try to estimate the rate of false discoveries in the candidate proteins which are inferred from the matches to the peptides. We will look at some of these interesting statistical questions that are critical to correct analysis of the promising technology of shotgun proteomics.
Project: (MATH7) Fast exact tests

Exact tests are tests for which the statistical significance is computed from the underlying distribution rather than, say using Monte Carlo simulations or saddle point approximations. Despite of their accuracy exact tests are often passed over as they tend to be too slow to be used in practice. We recently developed a technique that fuses ideas from large-deviation theory with the FFT (Fast Fourier Transform) that can significantly speed up the evaluation of some exact tests. In this project we would like to explore new ideas that we allow us to expand the applicability of our approach to other tests.

Dates: Nov-Dec, Dec-Jan
Pre-requisites: STAT2911
Group Projects: Up to 3 students
Supervisor: Associate Professor Uri Keich - uri.keich@sydney.edu.au

Project: (MATH8) Powers of maximal monotone operators

For a mapping $A : H \to H$ defined on a linear vector space $H$, the powers $A^2$, $A^3$, etc of $A$ can be defined through the composition $f \circ g$ of two mappings $f$ and $g$. Then $A^2 = A \circ A$, $A^3 = A \circ A \circ A$, etc. In this summer research project, we want to find an appropriate definition of powers $A^k$ of possible multi-valued mappings $A$ on $H$ satisfying a so-called monotonicity condition and to understand important relations to the evolution equation $u(t) + A^k u(t) = 0$, for $t > 0$. In the last year summer research project, we could successfully define and establish new properties of fractional powers $A^s$ of $A$ for $s \in (0,1)$. The research of this project will build-on these before going results.

Dates: Dec-Jan
Pre-requisites: MATH2021 and MATH2023/2923
Group Projects: Up to 2 students
Supervisor: Dr Daniel Hauer - daniel.hauer@sydney.edu.au
Project: (MATH9) The nature of Platonic and Archimedean solids
The aim is to study regular and semi-regular polyhedra, and search for their applications in mathematics and/or occurrence in nature.

Dates: Feb-Mar
Pre-requisites: MATH1002/1902
Group Projects: Up to 2 students
Supervisor: Dr Milena Radnovic – milena.radnovic@sydney.edu.au

Project: (MATH10) Modelling of infectious diseases
Student(s) working on this project will investigate some well-known models for the propagation of infectious diseases, and modify them in order to propose own models.

Dates: Feb-Mar
Pre-requisites: MATH1023/1923
Group Project: Up to 3 students
Supervisor: Dr Milena Radnovic – milena.radnovic@sydney.edu.au

Project: (MATH11) On the estimate of heritability and its uncertainty
2. Description Heritability is a key measure commonly used in genetics and plays a central role in many practical decision for selective breeding. It is a summary of the proportion of the phenotypic variability that is attributed to the average effects of the genes and determines the degree of resemblance between relatives. There are a number of existing methods for estimating heritability, however (1) estimates may be out of boundary with little attention given on how to deal with such situation and (2) very little work is done in quantifying the precision of these estimates. In this project we investigate various measures of heritability and their uncertainty based on specific applications to selective breeding.

Dates: Any time Nov-Feb
Pre-requisites: STAT2911 and STAT2912
Supervisor: Dr Emi Tanaka – emi.tanaka@sydney.edu.au

Project: (MATH12) Diagnostic tools for assumptions in linear mixed models
Linear mixed models are widely in use across many disciplines owing to its flexibility to model complex, correlated data. Often the key assumption of linear mixed models is that the random effects have a multivariate Gaussian distribution. Diagnostic checks of such assumptions are often neglected due to the difficulty of determining violations of the proposed model assumptions. For example, standard residual analysis cannot be readily performed or interpreted due to three different types of residuals in linear mixed models. In this project, we investigate diagnostic tools to detect violations of linear mixed model assumptions and its aid to model selection in linear mixed models.
Dates: Any time Nov-Feb
Pre-requisites: STAT3912
Supervisor: Dr Emi Tanaka - emi.tanaka@sydney.edu.au

**Project: (MATH13) Geometric topology**
The basic objects of geometric topology are curves and surfaces. This project studies them using techniques from geometry, algebra or combinatorics. Some basic questions that may be addressed are: How do you tell two knots apart? Can you quantify how complicated a given knot is? How do you tell two surfaces apart? How do you knot surfaces in four dimensions?

Dates: Nov-Dec or Feb-Mar
Pre-requisites: Some second year mathematics
Group Projects: Up to 6 students
Supervisor: Associate Professor Stephan Tillmann - stephan.tillmann@sydney.edu.au

**Project: (MATH14) The Mathematics of Imaging**
In the past decade we have discovered rich mathematical structures behind various models for imaging and tomography. For example, electric impedance tomography for tumour detection in anisotropic medium turns out to be intricately connected to the behaviour of the Laplace-Beltrami operator on Riemannian manifolds. Another example is seismic imaging where seismic waves are modeled by geodesics. The chosen student will take on a topic under the scope of the instructor’s Future Fellowship project. Depending on the student’s strength, the project can either be directed towards analysis/PDE or differential geometry.

Dates: Any time Nov-Feb
Pre-requisites: MATH2021/2921 and MATH2023/2923
Group Project: Up to 3 students
Supervisor: Dr Leo Tzou - leo.tzou@sydney.edu.au

**Project: (MATH15) Methods towards precision medicine**
Over the past decade, new and more powerful -omic tools have been applied to the study of complex disease such as cancer and generated a myriad of complex data. However, our general ability to analyse this data lags far behind our ability to produce it. This project is to develop statistical methods that deliver better prediction of outcome. In particular, this project investigates whether it is possible to establish the patient or sample specific accuracy by integrating public repository of multi-omics data.

Dates: Nov-Dec, Late Jan-Feb, Feb-Mar
Pre-requisite: Knowledge of R
Group Project: Up to 2 students
Project: (MATH16) Visualization of biomedical data with application to chronic kidney disease (CKD).

The aim of this project will examine a clinical study headed by A/Prof Germaine Wong aims to investigate the predictors of advanced colorectal neoplasia, and the consequences of routine screening using faecal immunochemical testing (FIT) for advanced colorectal neoplasia in people with CKD. The project will develop of a multi-stage model that identifies patients with CKD who may be at risk of developing colorectal cancer (CRC) and create an visualization tools for this information.

Dates: Nov-Dec, Late Jan-Feb, Feb-Mar

Pre-requisite: Knowledge of R

Group Project: Up to 2 students

Supervisor: Professor Jean Yang - jean.yang@sydney.edu.au

Project: (MATH17) Complexity analysis of stationary form of differential-difference equations

In this project we aim to study the behaviour of the stationary form of some known differential-difference equations through the method of algebraic entropy. Indeed, it is known that such equations can have only three possible behaviours: chaotic, integrable or linearisable. These behaviours are characterised by the rate of growth of the iterates of these equations, i.e. by measuring their complexity. With this analysis we want to uncover the underlying structures of these equations which is the first step to insert those equations in the general theory. The project is an hands-on one: the student will be taught the basic theory on algebraic entropy and will be introduced to the Julia programming language as fundamental tool to make explicit computations.

Dates: Jan-Feb or Feb-Mar

Prerequisites/additional information: Some basic experience with programming languages

Supervisor: Dr Giorgio Gubbiotti - giorgi.gubbiotti@sydney.edu.au

Secondary Supervisor: Prof Nalini Joshi - nalini.joshi@sydney.edu.au
Psychology

Project: (PSYC1) Cognitive Flexibility in Complex Problem Solving: Re-conceptualisations and measurement
Complex problem solving (CPS) is an umbrella term for a diverse range of approaches to the investigation and assessment of cognitive flexibility (defined as the ability to deal with novelty). CPS assessments range from high fidelity simulations with many inputs and outputs (e.g., commercial flight simulators), to “minimal complex systems” which present the simplest possible interaction of variables (typically deterministic and linear) needed to assess lower-bound CPS competencies. The summer project will explore and develop computerized simulations of CPS scenarios and microworld systems to study cognitive flexibility. Researchers from Durham University (UK) will be visiting during the summer to work on this project.

Dates: Nov-Dec

Pre-requisites: some coding experience and interests in cognitive-science/psychology would be advantageous

Secondary Supervisor: Prof Jens Beckmann - j.beckmann@durham.ac.uk - https://www.dur.ac.uk/research/directory/staff/?mode=staff&id=9625

Project: (PSYC2) Children’s thinking
This project examines how children construct their understanding of the world around them, how that process changes with age, and how children differ from each other in their understanding. Working on this project entails directly working with children, potentially ranging from 4 to 12 years old. You will take children through experimental procedures, and then further help with data analysis. The aim is that your work will contribute to a novel finding that is published in a peer-reviewed journal of child development.

Dates: Flexible


Project: (PSYC3) Exercise as possibly addictive: A rat model
When placed daily in an activity wheel rats run for a steadily increasing amount. Does this mean they become addicted to exercise? Or are there other explanations?

Dates: Jan-Feb

Pre-requisite: Psych 3011 Learning and behaviour

Supervisor: Emeritus Professor of Psychology - Robert Alan Boakes, bob.boakes@sydney.edu.au
Project: (PSYC4) Do people use different strategies to regulate others’ emotions when they are sad versus angry versus scared?
This project involves administering an online questionnaire of the strategies that people use to regulate others’ emotions, along with other questionnaires assessing wellbeing and positive functioning. The aim of the project is to find out whether people use different kinds of strategies for trying to regulate different kinds of emotions. The scholar will program the online questionnaire, recruit participants through a panel website (Prolific Academic), run the online questionnaire page, clean the data, help analyse the results, and help write a manuscript for publication.
Dates: Dec-Jan
Pre-requisite: PSYC2012
Supervisor: Ass Prof Carolyn MacCann - carolyn.maccann@sydney.edu.au

Project: (PSYC5) Meta-analysis of the dark triad personality traits and emotion regulation strategies
This project is a systematic literature review of available psychology databases to locate data examining the association between dark triad traits (psychopathy, machiavellianism, and narcissism) and the emotion regulation strategies of reappraisal and expressive suppression. The scholar will learn how to conduct a systematic review and use the meta-essentials package to conduct a meta-analysis (a quantitative summary of research), as well as help to develop hypotheses around which factors may moderate the personality/regulation relationships.
Dates: Dec/Jan
Pre-requisite: PSYC2012
Supervisor: Ass Prof Carolyn MacCann - carolyn.maccann@sydney.edu.au

Project: (PSYC6) Losing your sense of smell: an untapped marker of neurodegeneration
Dementia is now the second leading cause of death and disability internationally. However, accurate diagnosis takes 3-4 years after symptom onset due, in part, to the lack of a fast, cheap and non-invasive screening tests. Emerging evidence suggests that a reduction in sense of smell, represents one of the earliest markers of neurodegeneration. This project will explore olfactory function in patients with dementia using new universal and culture-free tests to determine the potential utility of these new tests for early and differential diagnosis. The student will learn to set-up an experimental protocol, recruit participants, administer olfactory tests and analyse performance.
Dates: Jan-Feb OR Feb-Mar (preference for Feb-Mar)
Supervisor: Dr. Aurélie Manuel Stocker
Secondary Supervisor: Prof Olivier Piguet
- olivier.piguet@sydney.edu.au http://sydney.edu.au/science/people/olivier.piguet.php
Geosciences

Project: (GEOS1) Reconstructing the history of carbonate deposition in the South Atlantic Ocean since 140 million years ago
The long-term carbon cycle is controlled by the exchange of carbon between the surface of the Earth and its interior on time scales of millions of years. Deep-sea sedimentary carbonate carbon is the least-known component of this cycle and its distribution is largely controlled by the depth of the carbonate compensation depth (CCD) in the ocean. The aim of this project is to reconstruct the CCD in the South Atlantic Ocean from 140 million years ago to the present-day using a newly developed pyBacktrack tool and sedimentological data from deep-sea drill sites.

Dates: Jan-Feb
Pre-requisites: GEOS2115/GEOS2915 or GEOS3103/GEOS3803 or GEOS3104/3804
Supervisor: Dr Adriana Dutkiewicz - adriana.dutkiewicz@sydney.edu.au
Secondary Supervisor: Prof Dietmar Muller - dietmar.muller@sydney.edu.au

Project: (GEOS2) Simulating continental precipitation through geological time
As continents move across latitudinal climate belts through geological time while global climate is fluctuating, regional precipitation undergoes enormous change. Annual rainfall is a primary driver of chemical and physical weathering, affecting erosion, the transfer of sediments and nutrients into sedimentary basins and the oceans, and the carbon cycle. This project will use the recently developed ATOM climate modelling software designed to model paleoclimate time series based on digital continental paleo-elevation maps. The output will be ground-truthed against precipitation indicators in geological record. The project is part of the Australian Research Council and industry-supported Basin Genesis Hub, and will lead to further research opportunities.

Dates: Jan-Feb
Pre-requisites: GEOS2115/GEOS2915 or GEOS2124/GEOS 2924 or GEOS3103/GEOS3803 or GEOS3104/3804
Supervisor: Prof Dietmar Muller - dietmar.muller@sydney.edu.au
Secondary Supervisor: Dr Rohitash Chandra - rohitash.chandra@sydney.edu.au
http://rohitash-chandra.github.io

Project: (GEOS3) Modelling surface ocean circulation through geological time
Surface ocean circulation through geological time has changed immensely. For example, an equatorial seaway connected the Pacific, Atlantic, and Indian oceans 60 million years ago, leading to different patterns in ocean circulation, heat transport, biological productivity and sedimentation. In this project we will model surface ocean circulation through geological time to investigate how changing configurations of continents and oceans have affected surface ocean circulation and coastal upwelling through time, using the recently developed ATOM climate modelling software. The model output will be evaluated against the deep sea sedimentation record in key locations. The project is part of the EarthByte Group’s effort to reconstruct paleogeography and the history of the ocean basins, and will lead to further research opportunities.

Dates: Jan-Feb
Pre-requisites: GEOS2115/GEOS2915 or GEOS2124/GEOS 2924 or GEOS3103/GEOS3803 or GEOS3104/3804

Supervisor: Prof Dietmar Muller - dietmar.muller@sydney.edu.au

Secondary Supervisor: Dr Adriana Dutkiewicz - adriana.dutkiewicz@sydney.edu.au

Project: (GEOS4) Machine learning methods for analysis of X-Ray tomography data in deformed rocks

Machine learning methods are gaining attention in areas of Earth science. Application of state-of-the-art microanalytical techniques, such as X-ray computed tomography, allows for the non-destructive study of the structure of rocks by generating big datasets and necessitates the development of automated methods that will allow for the treatment of these data. This project will utilise machine learning methods for processing 3D grain data and determining rock fabric, which is important for a wide range of processes in the Earth’s lithosphere.

Dates: Nov-Dec or Jan-Feb or Feb-Mar

Pre-requisites: Basic programming skills. Basic knowledge in data science preferable, but not a requirement.

Supervisor: Research Fellow Rohitash Chandra - rohitash.chandra@sydney.edu.au
http://rohitash-chandra.github.io

Secondary Supervisor: Lecturer Vasileios Chatzaras - vasileios.chatzaras@sydney.edu.au

Project: (GEOS5) Multi-core parallel tempering for extending BayesReef

py-Reef Core is a vertical reef growth simulation model for geological timescales. BayesReef has been proposed to estimate and provide uncertainty quantification for py-Reef Core which features environmental condition parameters. BayesReef features limitations when the size of the problem increases due to computational requirements in sampling and hence only a few parameters were estimated. This project extends Bayeslands using parallel to estimate dozens of parameters on a synthetic reef core dataset.

Dates: Nov-Dec or Jan-Feb or Feb-Mar

Pre-requisites: Basic programming skills. Basic knowledge in data science preferable, but not a requirement.

Supervisor: Research Fellow Rohitash Chandra - rohitash.chandra@sydney.edu.au
http://rohitash-chandra.github.io

Secondary Supervisor: Lecturer Tristan Salle - tristan.salles@sydney.edu.au

Project: (GEOS6) Landscape evolution using Bayeslands for a Fijiian island

Fiji lies in a tectonically complex area between the Australian Plate and the Pacific Plate and bordered with active extension fault lines around which most of the shallow earthquakes were centred. Badlands is a landscape evolution model that simulates topography growth over various times and scales. Recently, Badlands has been extended with Bayesian inference methodology in high-performance computing to estimate free parameters and provide uncertainty quantification in simulated topographies. This project uses Bayeslands to estimate climate parameters such as
precipitation rate and initial conditions such as initial topography for the selected Fijian island in order to simulate landscape evolution over millions of years.

Dates: Nov-Dec or Jan-Feb or Feb-Mar

Pre-requisites: Basic programming skills. Basic knowledge in data science preferable, but not a requirement.

Supervisor: Research Fellow Rohitash Chandra - rohitash.chandra@sydney.edu.au
http://rohitash-chandra.github.io
Professor Dietmar Muller - dietmar.muller@sydney.edu.au

Project: (GEOS7) Influence of volcanic arcs as barriers to ocean circulation

The opening and closing of oceanic gateways, narrow passageways facilitating exchange between ocean basins, has been linked to major changes in Earth’s climate. In this project you will investigate the role of volcanic arcs as barriers to ocean circulation in some key oceanic gateway regions. You will generate a series of end-member reconstructions for the evolving shape and depth of volcanic arcs and use these reconstructions as boundary input into a low-resolution ocean circulation model.

Dates: Nov-Dec OR Feb-Mar

Supervisor: Dr Maria Seton - maria.seton@sydney.edu.au

Project: (GEOS8) Food security and livelihood change in Myanmar

This project will involve the coding and analysis of qualitative interview data obtained from household surveys in Myanmar conducted in 2016 and 2017 by the team led by Prof Bill Pritchard. The student will work with Prof Pritchard to devise an appropriate coding frame and then use NVIVO software to sort household interview data into inductive categories to establish food/livelihood connections. The final stage will involve identifying major themes and preparing material for publication.

Dates: Jan-19

Pre-requisites: Completion of GEOS3333/3933 and aspirations to undertake Honours in Geography

Supervisor: Professor Bill Pritchard - bill.pritchard@sydney.edu.au

Project: (GEOS9) Landscape connectivity as a proxy for biodiversity

Mountains drive biological diversification by enlarging the range of environmental conditions available to local species, and fragmenting the landscape into a myriad of isolated ecological niches. They host a disproportionate fraction of terrestrial species, with higher endemism at higher elevations. Mountains act as refuges making the biosphere more resilient to climate changes, as species have to move across shorter distance to track optimum environmental conditions. This project consists in measuring the correlation between the landscape elevational connectivity (LEC) and a biodiversity index (alpha biodiversity).

Dates: Flexible
Pre-requisites: If you are interested in solving global challenges, this project is for you as long as you have some interest in at least of the following: geology, geomorphology, evolutionary biology, ecology.

Supervisor: Associate Professor Patrice Rey - patrice.rey@sydney.edu.au

Secondary Supervisor: Dr Tristan Salles - tristan.salles@sydney.edu.au

Project: (GEOS10) The tectonics and geodynamics of the Papuan Peninsula since the Cretaceous

The Papuan Peninsula, forming the north-eastern corner of the Australian continent, has evolved in a complex tectonic setting linking the Pacific and Tethyan oceans. The tectonic evolution, and in particular the history of subduction, has significant ramifications for the long-wavelength topography of the Australian continent during its northward journey since the Cretaceous. The project will analyse, and modify where necessary, the tectonic reconstructions in GPlates (www.gplates.org) in order to better constrain the evolution of this region. In particular, we will investigate alternative origins and positions of the Caroline Plate to explore the complex and oblique collision between the Caroline Arc and the Papua New Guinea margin. The project is part of the Basin GENESIS Hub where cutting-edge numerical Earth models are used to improve our understanding of geophysical processes across a range spatio-temporal scales, as well as help our industry partners better constrain their interpretations of complex tectonic regions like the Papuan Peninsula.

Dates: Dec-Feb

Supervisor: Dr Sabin Zahirovic - sabin.zahirovic@sydney.edu.au
https://www.earthbyte.org/tag/sabin-zahirovic/

Secondary Supervisor: A/Prof Patrice Rey - patrice.rey@sydney.edu.au
https://www.earthbyte.org/tag/patrice-rey/

Project: (GEOS11) Tectonic drivers of the deep carbon cycle and long-term climate

Plate tectonics controls the exchange of carbon from deep to shallow/surface planetary reservoirs, which modulates climate, biogeochemical processes, and even evolution on Earth. The tectonic driving parameters used in carbon box models are often decades old, leading to a poor quantification of the role of tectonics in driving atmospheric CO2 concentrations on geological timescales. This project will use our latest digital community plate reconstructions from GPlates (www.gplates.org) to link to a community carbon box model. This project will form the basis of future research to better constrain the time-evolving (and relative) contributions of CO2 from the plate-mantle system, and is part of an ongoing collaboration with the interdisciplinary and international Deep Carbon Observatory (https://deepcarbon.net/).

Dates: Dec-Feb

Supervisor: Dr Sabin Zahirovic - sabin.zahirovic@sydney.edu.au
https://www.earthbyte.org/tag/sabin-zahirovic/

Secondary Supervisor: Prof Dietmar Muller - dietmar.muller@sydney.edu.au
https://www.earthbyte.org/tag/dietmar-muller/
Project: (GEOS12) The role of ENGOs in environmental litigation

This project links to ongoing research about environmental protection regimes in our region. In this project we will investigate the role of Environmental Non-Government Organisations in pursuing environmental protection through litigation (court cases). We are interested in exploring the correlation between ENGO advocacy and activism and successful environmental defence litigation.

Dates: Feb - Mar
Pre-requisites: ENVI3111 or ENVI3911
Supervisor: Dr Josephine Gillespie - josephine.gillespie@sydney.edu.au

Project: (GEOS13) Influence of break-up obliquity on associated sedimentation basins

When continents break apart, extensional tectonics appears associated with the formation of basin fill with several kilometres of sediments. Most of these conjugate extensional margins have a pronounced asymmetry and very few attempts have been made to model and quantify the effect of different styles of extension on the erosion, transport and deposition of their sediments. It is now possible to couple lithospheric-scale 3D numerical high-performance computing models to study the rift evolution over space and time with simulations of the surface process using the code Badlands developed by Dr Tristan Salles at the University of Sydney. Using these models, this study will investigate the effect of different rifting velocities and obliquity on syn-rift basin stratigraphy and will aid in predicting basin resource accumulation. The project is part of the Australian Research Council and industry-supported Basin Genesis Hub, and will lead to further research opportunities.

Dates: Nov-Dec or Jan-Feb or Feb-Mar
Pre-requisites: GEOS2116, GEOS2124, GEOS3104
Supervisor: Dr Claire Mallard - claire.mallard@sydney.edu.au
Secondary Supervisor: Dr Tristan Salles - tristan.salles@sydney.edu.au
Life and Environmental Sciences

Project: (SOLES1) Can we immunise honey bees against virulent viruses?

Declines in honeybee health due to viral disease severely impacts the beekeeping industry and puts our food supply at risk. The goal of this project is to enable a novel method to increase honeybee resistance to viruses, using a natural bacterial symbiont of insects, Wolbachia. Wolbachia provides increased virus resistance in mosquitoes and flies, and is currently used to prevent the spread of mosquito-borne human disease. This project will investigate if Wolbachia can provide protection against viruses in honeybees. You will learn: how to collect honey bees from a hive; how to detect wolbachia in insects; and how to use microinjection equipment to inject wolbachia into honey bees.

Dates: Negotiable

Supervisor: Dr Emily Remnant - emily.remnant@sydney.edu.au

Project: (SOLES2) Models for estimating evolutionary relationships across the Tree of Life

The Tree of Life describes the evolutionary relationships among all of the organisms on Earth. These relationships can be estimated by using phylogenetic methods to analyse the DNA sequences of these organisms. However, phylogenetic methods require models of the evolutionary process. In this project, you will use cutting-edge software to test whether our current models are realistic or not. The results of the project will potentially be publishable in the form of a scientific paper.

Dates: Jan-Feb OR Feb-Mar

Supervisor: Dr David Duchene - david.duchene@sydney.edu.au

Secondary Supervisor: Professor Simon Ho - simon.ho@sydney.edu.au

Project: (SOLES3) Trophic links in remant oyster reefs

Large oyster reefs historically characterised estuaries on the South-East coast of Australia. These reefs played crucial roles in estuaries by filtering water, providing habitat for fish and invertebrates and protecting shoreline ecosystems. Nowadays, subtidal oyster reefs are mostly absent in the area due to human factors, including the harvesting of shells and live oysters since the 18th century. This project aims to evaluate trophic links between oysters and its associated assemblages in remnant oyster reefs in the Sydney area to inform restoration efforts.

Dates: Nov-Dec

Supervisor: Dr Ana B Bugnot - ana.bugnot@sydney.edu.au

Secondary Supervisor: Prof Ross Coleman - ross.coleman@sydney.edu.au

Project: (SOLES4) Nutrient cycling by oyster reefs
Large oyster reefs historically characterised estuaries on the South-East coast of Australia. These reefs played crucial roles in estuaries by filtering water, providing habitat for fish and invertebrates and protecting shoreline ecosystems. Nowadays, subtidal oyster reefs are mostly absent in the area due to human factors, including the harvesting of shells and live oysters since the 18th century. This project aims to evaluate how remnant oyster reefs affect surrounding sediments in order to evaluate the potential benefits of restoration efforts.

Dates: Nov-Dec

Supervisor: Dr Ana B Bugnot - ana.bugnot@sydney.edu.au

Secondary Supervisor: Prof Ross Coleman - ross.coleman@sydney.edu.au

**Project: (SOLES5) Understanding cell-cell signaling in cell polarity**

Project aims to understand how plant cells coordinate their polarity using confocal imaging and genetic mosaics.

Dates: Nov-Dec OR Jan-Feb

Supervisor: Associate Professor Marcus Heisler - marcus.heisler@sydney.edu.au


**Project: (SOLES6) Patterning mechanisms controlling leaf shape**

Project will investigate leaf development using live-imaging and mosaic analysis.

Dates: Feb-March

Supervisor: Associate Professor Marcus Heisler - marcus.heisler@sydney.edu.au


**Project: (SOLES7) The Impact of Climate Change Stressors on Marine Invertebrates**

This project will investigate the impacts of ocean warming and ocean acidification in context with near future projections on marine invertebrates with a focus on echinoderm and mollusc species. The research will entail rearing life history stages in ocean change conditions using facilities on campus and the Sydney Institute of Marine Science at Chowder Bay. Responses of the experimental animals will be compared using biomarkers of animal health (metabolism, cell stress markers, genetic markers, growth and morphology). The goal of the research is to determine which species may be the comparative ‘winners’ or ‘losers’ in the ocean change stakes.

Dates: Flexible

Supervisor: Professor Maria Byrne - maria.byrne@sydney.edu.au

**Project: (SOLES8) Role of light intensity on biomass partitioning in chickpea**

Chickpea varieties display different growth responses to high and low light intensities. The aim of this project is to determine the time when the plants perceive the signal.

Dates: Pref. Jan-Feb or Feb-Mar
Pre-requisites: 1st year biology and an interest in plant biology or sustainable agriculture

Supervisor: GRDC Senior Lecturer Helen Bramley - helen.bramley@sydney.edu.au

Secondary Supervisor: Postdoctoral Research Associate Sarah Purdy - sarah.purdy@sydney.edu.au

Project: (SOLES9) Does Fusarium pseudograminearum block transpirational flow in wheat stems?

Crown rot caused by the fungal pathogen, Fusarium pseudograminearum causes significant yield loss in Australian wheat crops, especially when water is limited. The fungus infects the roots and tillers, and is believed to block passage of water through the xylem but no studies have measured the rate of flow through infected plants. This project will measure hydraulic conductivity and transpiration in infected plants of wheat varieties known to differ in their tolerance to crown rot.

Dates: Pref. Feb-Mar

Pre-requisites: 1st year biology and an interest in plant biology or sustainable agriculture

Supervisor: GRDC Senior Lecturer Helen Bramley - helen.bramley@sydney.edu.au

Secondary Supervisor: Research Fellow Philip Davies - philip.davies@sydney.edu.au

Project: (SOLES10) Wilting points as a predictor of drought tolerance in wheat and chickpea

When leaves dehydrate under drought, bulk leaf turgor pressure decreases. The turgor loss point (also called permanent wilting point) is the leaf water potential when turgor is zero. At this point, many metabolic and physiological processes are impaired. Drought tolerance across ecological gradients has been associated with lower wilting points. This project will investigate whether there is genetic variation in wilting points of chickpea varieties and if it is related to their drought tolerance.

Dates: Pref. Feb-Mar (but Nov-Dec also possible)

Pre-requisites: 1st year biology and an interest in plant biology or sustainable agriculture

Supervisor: GRDC Senior Lecturer Helen Bramley - helen.bramley@sydney.edu.au

Project: (SOLES11) Contribution of seed size and quality to emergence and early vigour in chickpea

Farmers grow grain legumes like chickpea in their crop rotations because it helps to break disease cycles and because their ability to fix nitrogen from the atmosphere reduces the need for nitrogenous fertilisers. However, drought is the main constraint to improving chickpea yields. Rapid growth and accumulation of biomass (early vigour) may be useful traits to improve chickpea resistance to drought which tends to occur later in the growing season. This project will examine the role of the properties of the seeds on germination, emergence and early growth of chickpea.
**Project: (SOLES12) Heat stress in wheat**

Wheat crops in Australia often experience high temperatures during their reproductive and grain filling stages, which causes major yield losses. This project will examine whether the yield in wheat genotypes that vary in their tolerance to high temperature is related to their ability to store and remobilise water soluble carbohydrates during the grain filling stage.

**Dates: Feb-Mar**

**Pre-requisites:** 1st year biology and an interest in plant biology or sustainable agriculture

**Supervisor:** GRDC Senior Lecturer Helen Bramley - helen.bramley@sydney.edu.au

**Secondary Supervisor:** Postdoctoral Research Associate Purush Ramamoorthy - purushothaman.ramamoorthy@sydney.edu.au

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**Project: (SOLES13) Nectar Foraging of Birds on Urban Street Trees**

To investigate the foraging dynamics of urban nectar-consuming birds (e.g. rainbow lorikeet) on native trees and shrubs throughout the Sydney urban environment. Whilst most large street trees are native trees, they are often a mix of native trees that are and are not from the local region (endemic v non-endemic). This results in a floristic diversity that provides a large and constant amount of nectar resource for nectar using birds, insects and mammals. This project will look at the relationship between flowering density and bird usage.

**Dates:** Nov- Dec OR Dec-Jan OR Jan - Feb

**Pre-requisites:** Will need a car, access to a car, or willingness to travel around Sydney.

**Supervisor:** A/Prof Charlotte Taylor - charlotte.taylor@sydney.edu.au

**Secondary Supervisor:** Dr Adrian Davis - adrian.davis@sydney.edu.au
http://sydney.academia.edu/AdrianDavis

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**Project: (SOLES14) Variability in Nectar Production of Urban Plants**

To investigate the amount of and variability in the amount of nectar produced by various Australian native plants (e.g. Bottle brush, Banksia) that are common plantings throughout the Sydney urban environment. These plants provide an important and stable resource for many urban exploiting birds. Do nectar production dynamics vary between different habitats or plantings?

**Dates:** Nov- Dec OR Dec-Jan OR Jan - Feb
Pre-requisites: Will need a car, access to a car, or willingness to travel around Sydney.

Supervisor: A/Prof Charlotte Taylor - charlotte.taylor@sydney.edu.au  

Secondary Supervisor: Adrian Davis - adrian.davis@sydney.edu.au  
http://sydney.academia.edu/AdrianDavis

Project: (SOLES15) Soil Composition of Street Trees

Street trees are an important component of the urban habitat, both for human wellbeing and for urban wildlife. However, street trees often live in a hostile environment, adjoining roads, hard surfaces, increased heat etc. This project will sample and compare the soil composition (nutrients, pH, moisture) and temperature of flowering street trees in different habitats within the Sydney urban region.

Dates: Nov- Dec OR Dec-Jan OR Jan - Feb

Pre-requisites: Will need a car, access to a car, or willingness to travel around Sydney.

Supervisor: A/Prof Charlotte Taylor - charlotte.taylor@sydney.edu.au  

Secondary Supervisor: Dr Adrian Davis - adrian.davis@sydney.edu.au  
http://sydney.academia.edu/AdrianDavis

Project: (SOLES16) Pollinators in community gardens

2/3 of our fruits and vegetables are pollinated by insects yet there is growing concern about global pollinator declines. With their low levels of insecticide use and abundant flowers, cities may serve as important sites for pollinator conservation. In this project you will sample pollinators in community gardens around Sydney. You will learn how to identify different pollinators and flowers and you will contribute towards developing strategies to help make Sydney a 'pollinator friendly' city.

Dates: Flexible

Pre-requisites: Happy working with insects

Supervisor: Dr Tanya Latty - tanya.latty@sydney.edu.au  
www.tanyalatty.com

Project: (SOLES17) How do bees choose flowers?

Honey bees are important pollinator of a range of plants. In this project, you will investigate the behavioural strategies that bees use to choose between different types of flowers. You will learn how to make artificial flowers using a 3D printer and how to conduct behavioural experiments with bees.

Date: Flexible

Pre-requisites: Happy working with insects

Supervisor: Dr Tanya Latty - tanya.latty@sydney.edu.au  
www.tanyalatty.com
Project: (SOLES18) How smart are slime moulds?

Despite being brain less, slime mould amoebas are capable of astonishingly complex behaviours including solving mazes, making smart food choices and building efficient transportation networks. In this project you will investigate and compare the decision making abilities of several slime mould species. You will learn how to work with slime moulds in the lab, how to find and culture wild slime moulds, and how to design and analyse behavioural experiments.

Dates: Flexible
Pre-requisites: Happy working with a giant blob
Supervisor: Dr Tanya Latty - tanya.latty@sydney.edu.au
www.tanyalatty.com

Project: (SOLES19) The behaviour of stingless bees

Australian stingless bees have huge potential as crop pollinators yet we know very little about their behaviour and ecology. In particular, the details of the mating system remain a mystery. In this project you will help unravel the secrets of stingless bee mating behaviour through field experiments. You will learn how to work with stingless bees and how to design behavioural experiments.

Dates: Flexible
Pre-requisites: Happy working with insects
Supervisor: Dr Tanya Latty - tanya.latty@sydney.edu.au
www.tanyalatty.com

Project: (SOLES20) Indigenous perspectives on urban biodiversity

Urban ecologists typically focus on the immediate pressures that affect urban biodiversity, missing the opportunity to integrate traditional knowledge into urban ecosystem management. This project will explore Indigenous perspectives on culturally significant species or sites in the City of Sydney. This project would suit a student from a variety of backgrounds, seeking to develop interdisciplinary skills, integrating ecology into environmental management.

Dates: Jan-Feb OR Feb-Mar
Aboriginal and Torres Strait Islander Students are encouraged to apply
Supervisor: Associate Professor Dieter Hochuli - dieter.hochuli@sydney.edu.au
Secondary Supervisor: Dr Caragh Threlfall - caragh.threlfall@sydney.edu.au
www.caraghthrelfall.com

Project: (SOLES21) Ensiling waste vegetables

This project intends to optimise the use of vegetable waste as a feed source for ruminant livestock, whilst minimising greenhouse gas emissions, by employing analytical techniques, next generation sequencing, and silage making processes.
**Project: (SOLES22) Characterization of nutritive value of dehydrated silage compared to wet silage**

The shortage of land for forage production for ruminants in many countries makes the unit cost of most forages greater than that of grains. As a result, there is an increasing international forage market. This project will compare nutritive value between wet and dry silages.

**Dates: Jan-Feb**

**Supervisor:** A/Prof Alex V Chaves - alex.chaves@sydney.edu.au

https://sydney.edu.au/research/opportunities/supervisors/628

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**Project: (SOLES23) Effects of ozone on methane production and ruminal microbiome**

The objective of this study is to assess the effect of ozone using a total mixed ratio diet as substrate in a semi continuous RUSITEC apparatus on fermentation parameters, microbial population and methane production.

**Dates: Feb-Mar**

**Supervisor:** A/Prof Alex V Chaves - alex.chaves@sydney.edu.au

https://sydney.edu.au/research/opportunities/supervisors/628

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**Project: (SOLES24) Structural and functional characterization of novel peptides that target acetylcholine receptors and control T-cell signalling**

Acetylcholine receptors (AChR) play a major role in regulating immune function and molecules that can target specific AChR subtypes are good drug candidates for a range of inflammatory conditions. This project will use techniques from molecular biology, biophysics, interaction studies to molecular docking to examine how a set of novel peptides target acetylcholine receptors and control T-cell signalling. This work will be part of a collaborative project with researchers from USyd Westmead Clinical School and the University of Wollongong.

**Dates: To be negotiated**

**Prerequisites/additional information:** BCHM, MBLG or IMMUNOLOGY and equivalent

**Supervisor:** Dr Ann Kwan - ann.kwan@sydney.edu.au


**Secondary Supervisor:** Prof Nicholas Manolios - nicholas.manolios@sydney.edu.au

Project: (SOLES25) Engineering of hydrophobin proteins for structural studies and biotech applications

Hydrophobins are fungal proteins that can naturally self-assemble and coat structures and reverse their wettability. This property can be exploited for coating applications ranging from drug delivery to increasing the biocompatibility of surfaces. You will be investigating how changes in hydrophobin sequence affect its structure, assembly and coating properties.

Dates: To be negotiated

Prerequisites/additional information: BCHM, MBLG or IMMUNOLOGY and equivalent

Supervisor: Dr Ann Kwan - ann.kwan@sydney.edu.au

Project: (SOLES26) Interspecific competition between munbean and awnless barnyard grass under elevated CO2

Changes in the atmospheric CO2 levels have important consequences for the crop - weed interactions that are likely to vary by crop and weed type. Differential responses of C3 / C4 crops and weeds to CO2 enrichment are reported. This study will investigate the effect of elevated CO2 on competitive interaction of a C3 crop (mungbean) and C4 weed (awnless barnyard grass). The growth and photosynthetic responses of crop and weed to elevated conditions will be evaluated when grown with or without competition scenarios.

Dates: Feb-Mar

Supervisor: Dr. Asad Shabbir - asad.shabbir@sydney.edu.au

Secondary Supervisor: Associate Professor Michael J. Walsh - m.j.walsh@sydney.edu.au

Project: (SOLES27) Guppy love

The stakes are high when animals choose their mates; a good decision can mean a long and successful lineage, a poor decision may lead to an evolutionary dead end. But what are the characteristics that animals use to make these decisions, and how are they affected by the presence and the decisions of other animals in their environment? You will use the guppy, a freshwater fish, to examine this question and to shed light on this central evolutionary question.

Dates: Nov-Feb

Supervisor: Professor Ashley Ward

Project: (SOLES28) Learning, Information Use and Collective Decision-Making

For animals as well as for ourselves, life presents a series of decisions. Animal have to decide when and where to move in order to forage effectively, or to avoid their predators. You will examine how
social animals (in this case, fish) gather information and learn, and how they are able to share and integrate their information with other group members in order to make effective collective decisions.

Dates: Nov-Feb

Supervisor: Professor Ashley Ward

Project: (SOLES29) Ecological Dynamics on Subtropical Reefs

This project investigates ecological dynamics along the tropical-to-temperate transition zone in eastern Australia (SE-QLD and NSW), where tropical (e.g. corals) and temperate (e.g. kelp) marine species overlap at the limits of their distribution and environmental tolerances. The Denison scholar will learn how to identify corals and other benthic taxa from photographs and to determine spatial and temporal patterns in benthic communities in these dynamic environments that are already being transformed by changes in species distributions and interactions in response to warming oceans.

Dates: Nov - Dec

Prerequisites/additional information: Participants must have basic computer proficiency and be detail oriented. Previous experience with benthic and/or coral reef ecology is a bonus.

Supervisor: Dr Brigitte Sommer - brigitte.sommer@sydney.edu.au
https://www.researchgate.net/profile/Brigitte_Sommer2

Secondary Supervisor: A/Prof Will Figueira - will.figueira@sydney.edu.au

Project: (SOLES30) Exploration of Novel Weed Management Concepts

The student will research, design and test their own novel weed control method for a weed species of their choosing. Ideas should be simple, and research may include pot and/or field trials to determine efficacy. Weed species options are: sowthistle, windmill grass, feathertop rhodes grass, fleabane, and barnyard grass. Research conclusions will be reported in written form.

Dates: Jan-Feb

Prerequisites/additional information: Plant Biology or Agronomy

Supervisor: Postdoctoral Research Associate - Weed Biology Caleb Squires - caleb.squires@sydney.edu.au

Secondary Supervisor: Director - Weed Research Michael Walsh - m.j.walsh@sydney.edu.au
Project: (SOLES31) Machine vision and artificial intelligence for weed classification and control

The prospective student will plant and manage plots of summer weeds used in the development of machine vision algorithms, through the capture and classification of a training image dataset. Summer weeds could include barnyard grass, feathertop rhodes, sowthistle and fleabane in cotton, sorghum and mungbean. Efficacy, accuracy and robustness of the algorithm will be tested through an available targeting platform. A report will be written on the process and outcome of weeds classification.

Dates: Jan-Feb

Prerequisites/additional information: Machine vision (computer science)

Supervisor: Research Associate - Precision Weed Control Scientist Guy Coleman - guy.coleman@sydney.edu.au

Secondary Supervisor: Director - Weed Research Michael Walsh - m.j.walsh@sydney.edu.au

Project: (SOLES32) Effects of dietary glucose, fructose and fat intake on insulin and nutrient signalling.

The global epidemic of obesity and diabetes has been linked to increased consumption of ‘western diets’ containing an abundance of processed foods rich in fat and ‘simple carbohydrates’. Starch (a polysaccharide of glucose monomers) and sucrose (a disaccharide of fructose and glucose) are the two major carbohydrates in our diet. We aim to investigate how glucose, fructose and fat intake affects insulin and nutrient signalling in the liver and skeletal muscle. This will involve using liver and muscle tissues harvested from mice maintained on diets with various ratios of fat, glucose and fructose and studying the expression of candidate genes associated with insulin signalling, lipogenesis, lipid oxidation and inflammation. We can involve one student to work on liver samples and another to work with muscle samples.

Dates: Late Jan - Mar

Supervisor: Dr Jibran Wali - jibran.wali@sydney.edu.au

Project: (SOLES33) Investigating the impact of diet on immunometabolic outcomes

Our diet plays a pivotal role in immune regulation and determining health outcomes. This project will examine the impact of dietary elements (macronutrient composition, succinate) on inflammation and its consequence for metabolic health.

Dates: Nov-Dec, Dec-Jan, Jan-Feb or Feb-Mar

Supervisor: Dr Jibran Wali - jibran.wali@sydney.edu.au

Secondary Supervisor: Dr Jian Tan - jian.tan@sydney.edu.au
Project: (SOLES34) Assessing camera traps for dingo presence and interactions with cattle

Australian cattle production suffers high mortality rates. One of the key threats is from predation however, the impacts of dingo/wild dogs on the mortality of cattle is currently unknown. We are studying cattle mortality in the Northern Territory where we have placed camera traps to monitor cattle. This project will assess the presence of dingo/wild dogs from the recorded camera footage and create a database of information, including any interactions with cattle.

Dates: Nov-Dec, Dec-Jan

Supervisor: Dr Lucy Lush - lucy.lush@sydney.edu.au

Secondary Supervisor: Dr Thomas Newsome - thomas.newsome@sydney.edu.au
                      https://thomasnewsome.com

Project: (SOLES35) Mapping Liver Protein-Protein Interactions Using Crosslinking and the Fusion Tribrid Mass Spectrometer

Many of the Protein-Protein Interactions (PPIs) in liver are unknown. This project will use the latest proteomics methods to map these interactions and quantify changes in these interactions induced by different diets.

Dates: Nov-Dec OR Dec-Jan OR Jan-Feb OR Feb-Mar

Supervisor: Dr Mark Larance - mark.larance@sydney.edu.au

Project: (SOLES36) Analysis of Human Plasma Protein Changes after Intermittent Fasting using Proteomics

We have several collaborator who have performed intervention clinical trials of intermittent fasting (IF) in humans. In this project we will use plasma collected during these trials to determine protein and peptide hormone changes induced by the IF intervention using proteomics.

Dates: Nov-Dec OR Dec-Jan OR Jan-Feb OR Feb-Mar

Supervisor: Dr Mark Larance - mark.larance@sydney.edu.au

Project: (SOLES37) Identification of Transcription Factor Networks Regulated by Intermittent Fasting in Liver

We have analysed proteins regulated by intermittent fasting (IF) in livers of mice. This has allowed us to identify transcription factors (TFs) that are likely important in this response. This project will determine which of the TFs are important using Chromatin Immunoprecipitation (CHIP) and CRISPR-based technologies.
Dates: Nov-Dec OR Dec-Jan OR Jan-Feb OR Feb-Mar

Supervisor:  Dr Mark Larance - mark.larance@sydney.edu.au

Project: (SOLES38) Influence of crop harvest on the collection and distribution of weeds of cropping systems

To conserve soil moisture and crop residues new harvester fronts are being used that collect just the crop seed heads and pods. It is also suspected that these fronts will also facilitate the collection and redistribution of weed seeds during grain crop harvest. In field assessments will establish the amount of seed collection during harvest for the major crop weeds will be assessed in field at harvest time at three locations in NSW.

Dates: Nov-Dec

Supervisor:  Associate Professor Michael Walsh - m.j.walsh@sydney.edu.au

Project: (SOLES39) The Colour of Life

The world in colour presents a dazzling dimension of biological variation, yet we know little about how the ultimate source of colour patterns and vision --- sunlight --- shapes the evolution of visual signals and sensory systems. In this primarily field-based project you will work to detail the spatial, spectral, and temporal structure of terrestrial light environments, and examine whether the 'signatures' of different habitats are written into the colour patterns of key groups living therein, including birds, butterflies, and, flowers.

Dates: Nov-Dec

Supervisor:  Dr Thomas White - thomas.whie@sydney.edu.au
tomwhite.io

Project: (SOLES40) Animating the Study of Visual Communication

Visual communication is a dynamic process, yet much of our understanding of its ecology and evolution derives from work undertaken 'in stasis'. Here you will combine high-speed videography and precise measurements of wing colouration to examine the dynamics of sexual communication in a model butterfly system. The ultimate goal will be to uncover how complex visual information is weighed and integrated on-the-fly, and how adaptive evolution has shaped the temporal structure of communication systems to enable the effective exchange of information.

Dates: Feb-Mar

Supervisor:  Dr Thomas White - thomas.whie@sydney.edu.au
tomwhite.io
Project: (SOLES41) Assessing spatial variation in patterns of coral growth using innovative tools

Coral growth forms can vary along environmental gradients and this has ramifications for their ecology. This project will use innovative 3D modelling and comparison tools to evaluate changes in the 3D structure of coral taxa across a range of latitudinal and reef shelf gradients. The participant will learn how to build and compare 3D models as well as participate in novel data extraction. There may be the opportunity to participate in local, snorkel based field-work to refine methodologies.

Dates: Nov - Dec

Prerequisites/additional information: Participants must be detail oriented and have basic computer proficiency. Ability to snorkel and comfort conducting in-water work is a bonus.

Supervisor: A/Prof Will Figueira - will.figueira@sydney.edu.au

Secondary Supervisor: Prof. Maria Byrne - maria.byrne@sydney.edu.au