THE UNIVERSITY OF SYDNEY

Project List

Faculty of Science

Projects are arranged by school. Projects eligible for the Sydney Environment Institute Indigenous research scholarship are also listed separately.
Please consult the prerequisites carefully before nominating a project.

Sydney Environment Institute

SEIN01: The plants around us: using technology-led approaches to understand plant-animal interactions.

By understanding the plants growing around us we gain insights into how ecosystems work. This project explores the floral diversity in key plant families of the Sydney region using technology-led approaches (i.e. CT-generated 3D objects) to create shareable online content highlighting the importance of floral morphology in plant-animal interactions. Selection of plants for examination in this project will privilege those where First Nations namings are known and those used across the life science curriculum.

Supervisor(s): Rosanne Quinnell
Prerequisites: An interest in plant-animal interactions.
Maximum number of places available: 2
Project Location(s): Camperdown
Final assessment: Project report, 1-2 pages
Contact: mailto:rosanne.quinnell@sydney.edu.au

SEIN02: Promises and Perils of Climate Buffer Infrastructures as Adaptation: Case Studies from the Philippines.

As the impacts of climate change multiply, grey and green climate buffer infrastructures have been promoted as viable climate adaptation strategy, especially in coastal communities. This research project will examine how these adaptation projects foster (in)justice and (mal)adaptation through a comparative examination of two types of infrastructure projects: grey infrastructure (e.g. seawalls); and green infrastructure (e.g. wetlands, mangroves, marshes) in the Philippines. This multidisciplinary project will integrate insights and theories from geography, humanitarian engineering, development studies, and business to answer these questions.

Supervisor(s): Justin See
Prerequisites: Interest in climate change research, experience in conducting literature searches, ability to collate and summarise sources and key themes in the literature, knowledge of Endnote is preferred (but not required).
Maximum number of places available: 2
Project Location(s): Sydney University (the Quadrangle)
Final assessment: Project presentation, 5-10 minutes
Contact: mailto:justin.see@sydney.edu.au

SEIN03: The Botany Swamps and Wetlands Project: mapping the environmental landscape.

The remnant swamps and wetlands of urban and peri-urban Sydney, NSW, are the product of a long and complex history. Today, they provide a range of high-value ecosystem services and are thus shaped by a dense regulatory palimpsest that incorporates numerous regulatory instruments, including laws for the protection of threatened and endangered species and communities. In this project you will contribute to ongoing research about the environmental history and contemporary management of Sydney's freshwater wetlands.

Supervisor(s): Jo Gillespie
Prerequisites: Preference for students from the Geography and Environmental Studies majors; experience with GIS preferable but not necessary.
Maximum number of places available: 3
Project Location(s): Sydney
Final assessment: Project report, 1-2 pages
Contact: mailto:josephine.gillespie@sydney.edu.au

SEIN04: Assessing co-benefits of coastal blue carbon projects for improving the integrity of carbon offset reporting.

Nature-positive solutions are increasingly being recognized as key tools in addressing climate change, with significant attention on blue carbon ecosystems (seagrasses, mangroves and saltmarsh) due to their high value as carbon sinks and

importance to local communities and biodiversity. Blue carbon offsets are typically sold with the promise of carbon, community, and biodiversity benefit. Blue carbon offsets that deliver on and verifiably account for multiple benefits, could potentially reduce project risk, enhance market integrity, support communities, and contribute to several Sustainable Development Goals.
Although methods for verifying and reporting on carbon are established, other co-benefits, such as enhanced livelihoods, increased biodiversity, and improved water quality are often more difficult to verify through existing standards. Local communities are key actors in many successful blue-carbon projects, this internship project will critically assess mechanisms for reporting on equitable community outcomes of blue carbon projects through a systematic review of existing international projects.

Supervisor(s): Eleanor Bruce
Prerequisites: An interest and/or familiarity with Nature Positive Solutions and Blue Carbon projects
Maximum number of places available: 2
Final assessment: Project report, 1-2 pages
Contact: mailto:eleanor.bruce@sydney.edu.au

School of Chemistry

CHEM01: Search for missing symmetry in crystal structural databases.

The project is to become familiar with crystallographic symmetry and using existing software tools to search for incorrect entries in in the Inorganic Crystal Structure Database (https://en.wikipedia.org/wiki/Inorganic_Crystal_Structure_Database) and MAGNDATA (http://webbdcrista1.ehu.es/magndata/index.php?show_db=1). The identified erroneous entries will be corrected and reported in a short publication.

Supervisor(s): Max Avdeev
Prerequisites: Comfortable with database search and interest in learning a bit of crystallography and symmetry.
Maximum number of places available: 1

Project Location: Can be done from anywhere. Only internet access is required.
Final assessment: Project report, 1-2 pages
Contact: mailto:maxim.avdeev@sydney.edu.au

CHEM02: Designing proteins that can self-assemble.

In our lab (LauGroup.net), one of our main projects is the exploration of 'encapsulins' - proteins that spontaneously form 3D assemblies such as icosahedra. Encapsulins can be programmed to build artificial organelles in living cells, vessels for targeted drug delivery, and scaffolds for vaccine development. Control over 3D structure plays a critical role in all these applied scenarios.

This project involves molecular biology, protein biochemistry, and nanoscience. You will design new encapsulin proteins that can assemble into novel 3D structures, with the ultimate aim of developing organelles that can boost carbon dioxide capture in plants.

Supervisor(s): Yu Heng Lau
Prerequisites: Hands-on undergraduate lab experience in molecular biology, biochemistry, or related subjects is desirable.
Maximum number of places available: 1
Project Location: Main campus, Building G08
Final assessment: Project presentation, 5-10 minutes
Contact: mailto:yuheng.lau@sydney.edu.au

CHEM03: DISCOVERY OF CYCLIC PEPTIDE ANTIVIRALS FOR COVID-19.

The COVID pandemic caused by infection with the novel coronavirus “ SARS-CoV-2019“ need little introduction. Since the beginning of the pandemic there have been nearly 800 million cases and 7 million deaths globally as a result of viral infections. We have developed a cutting-edge peptide display platform to discover large families of cyclic peptides that inhibit viral proteins essential for cell entry and replication of

SARS-CoV-2. In this Denison scholarship project you will synthesise cyclic peptide antivirals using modified solid-phase peptide synthesis and assess their activity in biochemical assays. Compounds will also be screened against SARS-CoV-2 (with A/Prof Turville, Kirby Institute).

Supervisor(s): Richard Payne
Prerequisites: 2nd year chemistry units, an interest in medicinal chemistry and organic chemistry research
Maximum number of places available: 1
Project Location: School of Chemistry, Building F11
Final assessment: Project presentation, 5-10 minutes
Contact: mailto:richard.payne@sydney.edu.au

CHEM04: Purification and characterization of lipid binding protein domains.

Besides forming cell membranes, lipids play a plethora of roles, such as signaling, intracellular membrane trafficking, and forming hubs to recruit proteins to perform essential cellular functions. Proteins use their lipid-binding domains (LBDs) to interact with lipids at the membrane. We are interested in 1) identifying, purifying, and characterizing protein domains that can interact with physiologically relevant lipids in cells and 2) making biosensors out of these domains with suitable fluorescent reporter tags.

Supervisor(s): Kate Jolliffe/Bilge Ercan
Prerequisites: Prior hands-on molecular biology lab experience is desirable but not essential. Prior hands-on molecular biology lab experience is desirable but not essential. The essential factor is a willingness to learn, be flexible with time, and have a curious mind.
Maximum number of places available: 1
Project Location: G08 Molecular Bioscience Building, F11 Chemistry Building
Final assessment: Project report, 1-2 pages
Contact: mailto:bilge.ercan@sydney.edu.au

CHEM05: Device physics of organic solar cells.

In this project, you will simulate device operation of organic solar cells to better understand the role of charge generation and recombination on current-voltage characteristics for different device architectures and determine factors that underpin device efficiencies

Supervisor(s): Girish Lakhwani
Prerequisites: Completed PHYS2011 or CHEM2521, comfortable with MATLAB programming and graphing software
Maximum number of places available: 1
Project Location: School of Chemistry, Bldg F11
Final assessment: Project presentation, 5-10 minutes
Contact: mailto:Girish.lakhwani@sydney.edu.au

CHEM06: Spectroscopy using superchiral light.

Detection of molecular chirality is vital for varied applications in pharmaceuticals, sensors and displays. Circularly polarised light is chiral in nature and is used to optically detect chiral molecules, however, is limited in its capacity to detect low molecular concentration or single molecules because the light is much larger than molecular dimensions and generates a weak optical response. In this rather challenging project, you will learn to controllably generate highly twisted superchiral light to enhance the optical response thereby increasing the molecular footprint for high precision detection.

Supervisor(s): Girish Lakhwani
Prerequisites: Completed CHEM2521 or PHYS2011, an interest in optical spectroscopy
Maximum number of places available: 1
Project Location: School of Chemistry, Bldg F11
Final assessment: Project presentation, 5-10 minutes
Contact: mailto:Girish.lakhwani@sydney.edu.au

CHEM07: Time tracking energy and charge transfer in photochromic materials.

Soft condensed matter covers a broad range of fields from biology to optoelectronics and photonics. Within this, conjugated materials demonstrate both ordered and disordered phases depending on the chromophore arrangement. While strong electronic coupling between chromophores promotes delocalisation of the optical excitation, weak coupling makes energy vary from site to site limiting the extent of energy and charge transfer that is crucial to the operation of optoelectronic devices. This project will use time-correlated single photon counting (TCSPC) and transient absorption (TA) spectroscopy to identify role of disorder on energy transfer.

Supervisor(s): Girish Lakhwani
Prerequisites: Completed CHEM2521 or PHYS2011, an interest in laser spectroscopy
Maximum number of places available: 2
Project Location: School of Chemistry, Bldg F11
Final assessment: Project presentation, 5-10 minutes
Contact: mailto:Girish.lakhwani@sydney.edu.au

CHEM08: Bioinformatic analysis of Ion Pump Function and Regulation.

Ion pumps such as the sodium pump and the gastric proton pump perform vital physiological functions, e.g., in nerve, muscle, the kidney and the stomach. Although many structures with atomic level information have been published over the past few years, these have not provided complete answers to the questions of how these pumps operate or are regulated. Key domains of the pump molecules are simply not visible in the published structures. In this project we will approach these questions from a bioinformatic perspective, considering the molecular evolution of the pump molecules and their reaction partners.

Supervisor(s): Ronald Clarke
Prerequisites: A broad fundamental interest in basic life sciences.
Maximum number of places available: 2

Project Location: School of Chemistry
Final assessment: Project report, 1-2 pages
Contact: mailto:ronald.clarke@sydney.edu.au

CHEM09: Designing a Membrane for a fuel cell.

The membrane electrode assembly (MEA) is the heart of a fuel cell, where the core electrochemical functions occur. This project will focus on using an ultrasonic deposition system to fabricate MEAs that are optimized for application in self-breathing fuel cells.

Supervisor(s): Francois Aguey-Zinsou
Prerequisites: Have acquired laboratory experience during the teaching sessions.
Maximum number of places available: 2
Project Location: School of Chemistry
Final assessment: Project presentation, 5-10 minutes
Contact: mailto:f.aguey@sydney.edu.au

CHEM10*:* Characterisation of Microbial Secondary Metabolite Pathways.

This project will use molecular biology techniques to clone, express, and biochemically characterise secondary metabolites which generate antibiotics. This knowledge will be used to generate analogs of natural products for drug discovery efforts such as antibiotics.

Supervisor(s): Constance Bailey
Prerequisites: the student must have interest and knowledge in biological chemistry and biochemistry
Maximum number of places available: 2
Project Location: G08 506, 775
Final assessment: Project presentation, 5-10 minutes
Contact: mailto:constance.bailey@sydney.edu.au

CHEM11: Heterologous expression of darobactins in gram positive hosts.

Darobactin is an important antibiotic that targets a channel specific to gram negative infections. We are interested in making it in gram positive hosts as a means to overcome self-toxicity. This involves cloning novel pathways as well as fermenting them in heterologous hosts.

Supervisor(s): Constance Bailey
Prerequisites: basic understanding of first year chemistry and some understanding of biological principles
Maximum number of places available: 2
Project Location: G08 501, 775
Final assessment: Project presentation, 5-10 minutes
Contact: mailto:constance.bailey@sydney.edu.au

CHEM12: Slippery liquid-like coatings applied on microstructured surfaces.

Our group has recently discovered the mechanism that makes nanothin coatings super-slippery to liquids droplets. These molecularly thin coatings can be formed on silicon and other oxide substrates, and they turn the surface properties of glass into those of slippery Teflon, but without the use of any fluorine (which bioaccumulates, and therefore should be avoided). We have so far established the conditions of formation, stability and uniformity of these monolayers on smooth substrates, and we want to establish whether the coatings will be just as slippery when applied on microstructured substrates. In this project the Denison scholar will fabricate monolayers using polydimethylsiloxane layers self-assembled on solid microstructured substrates, made with laser ablation by our collaborators. The project will combine experimental procedures already established in the lab to produce new self-assembled monolayers which have anti-adhesive surface properties.

Supervisor(s): Chiara Neto
Prerequisites: Interest in experimental work relating to surface science and nanoscience

Maximum number of places available: 1
Project Location: School of Chemistry, lab 319
Final assessment: Project presentation, 5-10 minutes
Contact: mailto:chiara.neto@sydney.edu.au

CHEM13: Integrating citizen science and science communication.

Learning By Doing (LBD) is an interdisciplinary project that aims to implement citizen science in NSW schools. We have been running school-based workshops for the citizen science projects Breaking Good and Mozzie Monitors. We are now looking for a student to evaluate if and how these citizen science workshops integrate science communication principles as part of the Science Summer Research Experience Program.

This six-week project will map these resources to the core models and frameworks of science communication. It will also involve developing some science communication pieces to disseminate the project outcomes, including blogs and graphics.

Supervisor(s): Larissa Braz Sousa
Prerequisites: Experience in the different modes of science communication and tailoring scientific content to diverse audiences.
Maximum number of places available: 1
Project Location: Chemistry Building F11, Camperdown
Final assessment: Project report, 1-2 pages
Contact: mailto:Larissa.brazsousa@sydney.edu.au

CHEM14: Renewable Hydrogen Cycle.

Hydrogen, a promising green energy source, has significant potential for shaping our sustainable future. Central to the renewable hydrogen cycle, electrochemistry plays a crucial role. The electrochemical processes within this cycle are intricately influenced by surface attributes, with reaction pathways varying according to material composition and surface arrangements. This project focuses on leveraging cutting-

edge scanning electrochemical probe microscopy techniques to reveal the intimate connection between surface structure and electrochemical activity on electrode surfaces. This involves generating nanoscale electrochemical maps and dynamic visuals.

Supervisor(s): Kaye Minkyung Kang
Prerequisites: an interest in surface science and nanoscience, hands on lab experience
Maximum number of places available: 2
Project Location: Chemistry room 113/148
Final assessment: Project presentation, 5-10 minutes
Contact: mailto:minkyung.kang@sydney.edu.au

School of Geosciences

GEOS01: Urban Geology

In an urban environment, faults and fractures pose a range of environmental, engineering and hazard issues that need to be understood to be mitigated. These structures weaken the strength of the geological framework that supports surface and underground infrastructures, and they may be at the origin of seismic activities. In this project you will study the structure and geometry of fault and fracture networks in Sydney Metropolitan Area, documenting their geohazard consequences.

Supervisor(s): Vasileios Chatzaras
Prerequisites: Hands on lab experience and/or an interest in field analysis.
Maximum number of places available: 1
Project Location: Camperdown, Madsen Building F09
Final assessment: Project presentation, 5-10 minutes
Contact: mailto:vasileios.chatzaras@sydney.edu.au

GEOS02: Microanalysis, Mineral Physics, Plate Dynamics.

Plate tectonics, the unifying theory that explains how Earth works, is controlled by processes taking place in micro- to nano-scale. In this project, you will combine results from microanalyses and calculations of the seismic properties of minerals to understand plate dynamics along major transform boundaries.

Supervisor(s): Vasileios Chatzaras
Prerequisites: Skills in Matlab; interest in microanalysis
Maximum number of places available: 1
Project Location: School of Geosciences, Madsen Building F09
Final assessment: Project presentation, 5-10 minutes
Contact: mailto:Vasileios.chatzaras@sydney.edu.au

GEOS03: Urban metabolism and infrastructure in Sydney.

In this project, students will investigate the urban metabolic processes of urban infrastructure development in Sydney. There are two primary components of this research project: a scoping literature review focused on urban metabolism and urban infrastructure, and then an investigation of the metabolic processes that make up infrastructure development using the case study of a major development in Sydney at the Western Harbour Tunnel. In this investigation, students will focus on the labour processes and material dynamics of infrastructure projects in order to highlight the socioecological outcomes of infrastructure development.

Supervisor(s): Sophie Webber
Prerequisites: Suitable students will have completed some geography (or political economy) units of study and have an interest in urban geography and/or urban political ecology.
Maximum number of places available: 2
Project Location: Sydney
Final assessment: Project presentation, 5-10 minutes
Contact: mailto:sophie.webber@sydney.edu.au

GEOS04: Land use change for infrastructure development in Fiji.

Many countries in the global South are undergoing an infrastructural transformation, to keep up with rapid urbanisation and manage the effects of climate change. Building this infrastructure requires sourcing enormous amounts of aggregate and other materials. In this project, students will use the case study of Fiji's main island Viti Levu. Working with project supervisors, Dr Sophie Webber and Dr Kevin Davies, students will examine inter-annual changes in satellite images to identify land-use transformations associated with quarrying and river gravel mining. This project will, therefore, begin to map the expansive material dynamics of urban infrastructure development.

Supervisor(s): Sophie Webber
Prerequisites: Students will have some experience working with GIS, and there is a preference for students who have completed OLET1610 GIS Geographic Information Systems and OLET2612 GIS: Thinking Spatially.
Maximum number of places available: 1
Project Location: Sydney
Final assessment: Project presentation, 5-10 minutes
Contact: mailto:sophie.webber@sydney.edu.au

GEOS05: Mapping bus stop shelters in a sweltering city.

Buses are an essential part of our public transport system - but if it's too hot to wait for the bus, this will undermine the ability of our public transport system to facilitate mobility and reduce emissions. This research is part of a collaboration with community organisation Sweltering Cities, and will contribute to a citizen science project mapping the quantity and quality of shelter at bus stops across Sydney. Focusing especially on the city's hottest suburbs, summer researchers will be working with communities to identify places where lack of shelter is negatively impacting public transport use, and to build a case for investment in adaptive bus stop infrastructures for our climate changed future.

Supervisor(s): Kurt Iveson
Prerequisites: Urban geography units, interest in urban transport infrastructure

Maximum number of places available: 2
Project Location: Sydney
Final assessment: Project report, 1-2 pages
Contact: mailto:kurt.iveson@sydney.edu.au

GEOS06: Promises and Perils of Climate Buffer Infrastructures as Adaptation: Case Studies from the Philippines.

As the impacts of climate change multiply, grey and green climate buffer infrastructures have been promoted as viable climate adaptation strategy, especially in coastal communities. This research project will examine how these adaptation projects foster (in)justice and (mal)adaptation through a comparative examination of two types of infrastructure projects: grey infrastructure (e.g. seawalls); and green infrastructure (e.g. wetlands, mangroves, marshes) in the Philippines. This multidisciplinary project will integrate insights and theories from geography, humanitarian engineering, development studies, and business to answer these questions.

Supervisor(s): Justin See
Prerequisites: Interest in climate change research, experience in conducting literature searches, ability to collate and summarise sources and key themes in the literature, knowledge of Endnote is preferred (but not required)Climate adaptation, humanitarian engineering, development studies, and business.
Maximum number of places available: 2
Project Location: Sydney University (the Quadrangle)
Final assessment: Project presentation, 5-10 minutes
Contact: mailto:justin.see@sydney.edu.au

GEOS07: The Botany Swamps and Wetlands Project: mapping the environmental landscape.

The remnant swamps and wetlands of urban and peri-urban Sydney, NSW, are the product of a long and complex history. Today, they provide a range of high-value

ecosystem services and are thus shaped by a dense regulatory palimpsest that incorporates numerous regulatory instruments, including laws for the protection of threatened and endangered species and communities. In this project you will contribute to ongoing research about the environmental history and contemporary management of Sydney's freshwater wetlands. Applying your interests and skills with the guidance of academic staff, you will research the historical development of wetland ecosystems and the regulatory structures that have shaped them.

Supervisor(s): Jo Gillespie
Prerequisites: Preference for students from the Geography and Environmental Studies majors; experience with GIS preferable but not necessary.
Maximum number of places available: 3
Project Location: Sydney
Final assessment: Project report, 1-2 pages
Contact: mailto:josephine.gillespie@sydney.edu.au

GEOS08: Assessing co-benefits of coastal blue carbon projects for improving the integrity of carbon offset reporting.

Nature-positive solutions are increasingly being recognized as key tools in addressing climate change, with significant attention on blue carbon ecosystems (seagrasses, mangroves and saltmarsh) due to their high value as carbon sinks and importance to local communities and biodiversity. Blue carbon offsets are typically sold with the promise of carbon, community, and biodiversity benefit. Blue carbon offsets that deliver on and verifiably account for multiple benefits, could potentially reduce project risk, enhance market integrity, support communities, and contribute to several Sustainable Development Goals.

Although methods for verifying and reporting on carbon are established, other co-benefits, such as enhanced livelihoods, increased biodiversity, and improved water quality are often more difficult to verify through existing standards. Local communities are key actors in many successful blue-carbon projects, this internship project will critically assess mechanisms for reporting on equitable community outcomes of blue carbon projects through a systematic review of existing international projects.

Supervisor(s): Eleanor Bruce
Prerequisites: An interest and/or familiarity with Nature Positive Solutions and Blue Carbon projects
Maximum number of places available: 2
Project Location: Camperdown Campus
Final assessment: Project report, 1-2 pages
Contact: mailto:eleanor.bruce@sydney.edu.au

School of Physics

PHYS01: HOW DOES THE BRAIN COMPUTE? DISTRIBUTED DYNAMICAL COMPUTATION IN NEURAL CIRCUITS.

One of the most fundamental problems about the brain is how it computes. To answer this question, we have presented a concept of distributed dynamical computation (DDC), in which neural computation or information processing is carried out by interacting, propagating neural waves. This concept can unify dynamical and computational perspectives of the brain, which used to have great gaps between each other. The project will involve making further links between neural dynamics and computation, including studying the neural circuit models developed by our group to reveal the physical principles of key brain functions such as visual processing and attention.

Supervisor(s): Pulin Gong
Prerequisites: first-year Physics units
Maximum number of places available: 3
Project Location: Madsen Building, Camperdown Campus
Final assessment: Project report, 1-2 pages
Contact: mailto:pulin.gong@sydney.edu.au

PHYS02: THE PHYSICS OF DEEP LEARNING IN ARTIFICIAL INTELLIGENCE.

Deep neural networks (DNNs) widely used in artificial intelligence can be trained to effectively solve many real-world problems such as speech recognition, object detection, and drug discovery. However, our understanding of why they are so effective is lacking. The project will involve studying how fractal, self-similar geometry structures of loss function landscapes interact with a learning algorithm (i.e., stochastic gradient descent) to give rise to complex learning dynamics and the resultant effectiveness of DNNs. These complex learning dynamics will then be applied to develop new learning algorithms.

Supervisor(s): Pulin Gong
Prerequisites: first-year Physics units
Maximum number of places available: 2
Project Location: Madsen Building, Camperdown Campus
Final assessment: Project report, 1-2 pages
Contact: mailto:pulin.gong@sydney.edu.au

PHYS03: Interpreting deep learning-derived time-series features.

Recent years have seen an explosion of deep neural network-based algorithms for inferring low-dimensional representations of complex time-varying patterns measured from complex dynamical systems. While powerful, they can be difficult to interpret with respect to existing time-series theory, hence the need for interpretable AI. In this work, the student will compare some existing time-series features (like Google's Audioset features) to the thousands of theory-derived features in the hctsa library, demonstrating a method for interpreting time-series features and perhaps identifying promising directions for developing new time-series theory.

Supervisor(s): Ben Fulcher
Prerequisites: Students should be comfortable with coding and performing numerical analysis in a language like python, Matlab, or Julia
Maximum number of places available: 1
Project Location: Madsen Building, Camperdown

Final assessment: Project presentation, 5-10 minutes
Contact: mailto:ben.fulcher@sydney.edu.au

PHYS04: Detecting dark matter with liquid xenon.

Dark matter is an invisible substance that dominates the mass budget of the Universe and exists all around us in the galaxy. We have detected dark matter's gravitational influence on normal matter but are yet to uncover anything about its fundamental particle nature. Right now, we are building huge particle detectors underground to try and search for the extremely rare interactions between dark matter and normal matter. We think one of the best materials to use for doing this is liquid xenon, and currently Austrlia is part of a global collaboration that is planning the next generation of giant underground liquid xenon-based detectors.
In this project, you will be able to be a part of that planning, from evaluating theoretical particle physics models all the way to determining real experimental signals that can be detected in a laboratory. The project is intended to be open-ended and guided by student initiative and interests.

Supervisor(s): Ciaran O'Hare
Prerequisites: First year physics, some coding experience
Maximum number of places available: 2
Project Location: School of Physics, A28
Final assessment: Project presentation, 5-10 minutes
Contact: mailto:ciaran.ohare@sydney.edu.au

PHYS05: Parameter optimisation for sleep-wake cycles modelling.

Prediction and optimisation of sleep, circadian rhythms, and alertness are critical in the modern 24/7 society to help reduce the risk of accidents due to fatigue and prevent/minimise disorders associated with inadequate sleep and circadian misalignment. This project aims to test and calibrate an established biophysical model of sleep and alertness against a large set of experiments to ensure the robustness and accuracy of predictions. You will learn to use optimisation algorithms

for parameter fitting, simulation of experiments, and modelling of sleep and circadian rhythms using mathematics and coding. Coding experience is essential for the project.

Supervisor(s): Svetlana Postnova
Prerequisites: coding experience is essential (the project will use Matlab)
Maximum number of places available: 2
Project Location: Madsen Building or remote
Final assessment: Project presentation, 5-10 minutes
Contact: mailto:svetlana.postnova@sydney.edu.au

PHYS06: Building Better Qubits.

Quantum computers are hard to make; performing a quantum computation requires precise control of many, incredibly fragile quantum systems. Though the basic recipe for a quantum computer is relatively concrete, finding and constructing real world quantum systems that can completely satisfy these criteria has proven difficult. In this project, you will explore schemes for "next-gen" superconducting qubits that promise to be much more resilient to noise, at the cost of being more of a headache for experimentalists to engineer. Is the extra effort for experimental realisation worth it? How "idealised" do these systems need to be until we see the reduction in noise that the theoretical proposals are advertising?

Supervisor(s): Thomas Smith
Prerequisites: Second-year quantum mechanics.
Maximum number of places available: 2
Project Location: A28
Final assessment: Project presentation, 5-10 minutes
Contact: mailto:thomas.b.smith@sydney.edu.au

PHYS07: Large-scale quantum simulation with trapped ions.

The controlled simulation of dynamics in quantum-many body systems is of central interest in furthering our understanding of phenomena such as superconductivity and quantum magnetism. Specially designed Penning traps enable experimental investigations into these topics using hundreds of ions trapped simultaneously inside a large, superconducting magnet. We have recently brought online the first and only such system in Australia at the Sydney Nanoscience Hub, and now routinely trap large crystals of beryllium ions. Possible summer student projects involve characterising coupling between the ions using a custom UV laser system, hardware-software interfacing, hardware development, and trap operation. These topics involve experimental work in the laboratory and complementary numerical simulations and will adapt based on starting date and current needs.

Supervisor(s): Robert Wolf
Prerequisites: python programming basics of advantage but not required
Maximum number of places available: 2
Project Location: Sydney Nanoscience Hub
Final assessment: Project presentation, 5-10 minutes
Contact: mailto:robert.wolf@sydney.edu.au

PHYS08: Quartic solitons in an optical fibre cavity.

We recently discovered a new type of shape preserving optical pulses, arising from the balance between fourth order dispersion and Kerr nonlinearity, known as pure-quartic solitons. The aim of this project is to numerically investigate the generation of these pure-quartic solitons in passive fibre cavities.

The students will learn about ultrafast nonlinear physics, used in state-of-the-arts optical systems, and will develop advanced numerical modelling and theoretical skills.

Supervisor(s): Antoine Runge
Prerequisites: first-year Physics, first-year Mathematics
Maximum number of places available: 2

Project Location: School of Physics
Final assessment: Project presentation, 5-10 minutes
Contact: mailto:antoine.runge@sydney.edu.au

PHYS09: Investigating materials for a quantum internet.

This project will focus on crystals embedded with the rare-earth ion erbium (an element that is essential to today's classical internet infrastructure). The project will develop experiments to test the quantum optical and spin properties of erbium ions and probe interactions at the atomic scale. You will work in the Quantum Integration Laboratory housed in the Sydney Nanoscience Hub, and have the opportunity to interact with other quantum research groups from Australia and around the globe. You will gain experience in fields including experiment design, quantum light-matter interactions, cryogenic systems, and magnetic resonance.

Supervisor(s): John Bartholomew
Prerequisites: An interest in quantum information technology, comfortable working in a hands-on lab environment, undergraduate knowledge of quantum physics very useful but not essential, thrives in an environment where diversity is celebrated.
Maximum number of places available: 1
Project Location: Sydney Nanoscience Hub, Building A31, Camperdown Campus
Final assessment: Project presentation, 5-10 minutes
Contact: mailto:john.bartholomew@sydney.edu.au

PHYS10: Development of novel sensor for methane.

Methane is one of the most dangerous greenhouse gases, with e greenhouse warming potential that is 80 times that of Co2 over a 20 year period. Sensing methane cheaply and effectively remains a challenge. In this project will explore the use of a novel Fibre Bragg Grating based sensor, which replicates the absorption spectrum.

Supervisor(s): Maryanne Large

Prerequisites: hands on experience with optics, interest in environmental sensing
Maximum number of places available: 2
Project Location: School of Physics
Final assessment: Project report, 1-2 pages
Contact: mailto:maryanne.large@sydney.edu.au

PHYS11: Why and where do galaxies form stars?

Star formation is central the the life of a galaxy. How a galaxy forms stars, and where in the galaxy those stars are formed, are central questions that need to be answered if we want to understand how galaxies evolve. Using new data that shows the spatial distribution of star formation you will explore substructure and determine what properties the substructure is most strongly related to. This project will be largely computational and some experience with python will be an advantage.

Supervisor(s): Scott Croom
Prerequisites: Familiarity with programing in python.
Maximum number of places available: 2
Project Location: School of Physics, A28
Final assessment: Project presentation, 5-10 minutes
Contact: mailto:scott.croom@sydney.edu.au

PHYS12: Data-driven modelling of social systems.

With the abundance of social media data we can examine aggregate activity on social networks. What drives people to extreme ideological positions? What types of communities do people form? How do these different communities interact? In this project you will seek to model the dominant features which emerge when analysing large scale social network data.

Supervisor(s): Tristram Alexander

Prerequisites: First-year mathematics and Physics units. The project will be based on Python coding. Python programming is not a prerequisite (you will learn during the project), but some comfort with computer-based work is needed.
Maximum number of places available: 2
Project Location: School of Physics
Final assessment: Project report, 1-2 pages
Contact: mailto:tristram.alexander@sydney.edu.au

PHYS13: Microfabricated surface ion trap.

Work on setting up a new experiment to use microfabricated ion traps, this includes planning, designing and assembling optical, electronic and vacuum systems. Work would also include simulating electromagnetic fields and designing new microwave and radio-frequency systems. Some work in estimating the quantum behaviour of the trapped ion qubits.

Supervisor(s): Tomas Navickas
Prerequisites: Some experience with coding and simulating physical systems, some hands on lab experience
Maximum number of places available: 1
Project Location: QCL group, SNH building
Final assessment: Project presentation, 5-10 minutes
Contact: mailto:tomas.navickas@sydney.edu.au

PHYS14: Laser system design and assembly.

Design and assembly of laser systems to operate an ion trap experiment. The student will build new systems to stabilise the laser frequency by using electronic feedback.Project also includes working on electronic control systems.

Supervisor(s): Tomas Navickas
Prerequisites: Some hands on lab experience
Maximum number of places available: 1

Project Location: Sydney Nanoscience Hub, lab 2021
Final assessment: Project presentation, 5-10 minutes
Contact: mailto:tomas.navickas@sydney.edu.au

School of Psychology

PSYC01: Neural mechanisms of Bayesian perception: an EEG study.

Perception is often modelled as a process of active inference, whereby prior expectations are combined with noisy sensory measurements to estimate the structure of the world. This mathematical framework has proven critical to understanding perception, cognition, motor control, and social interaction. While theoretical work has shown how priors can be computed from environmental statistics, their neural instantiation could be realised through multiple competing encoding schemes. This study will apply generative modelling and forward encoding analyses to the brain activity of human participants, collected using electroencephalography (EEG), in an attempt to establish an encoding scheme that is sufficient for optimal inference.

Supervisor(s): Reuben Rideuax
Prerequisites: An interest in perception, cognition, and neuroscience. First- and second-year psychology units or equivalent.
Maximum number of places available: 2
Project Location: Griffith-Taylor building
Final assessment: Project presentation, 5-10 minutes
Contact: mailto:reuben.rideaux@sydney.edu.au

PSYC02: Predictive learning and transcranial magnetic stimulation.

The brain is constantly learning and making predictions - learning about the relationships between events in the world, and making predictions about future

consequences. Predictive learning allows us to anticipate the trajectory of a ball, the next note in a melody, and the enjoyment of eating our favourite food. Impairments in predictive learning are also associated with psychological conditions such as mood disorders and schizophrenia. This project will use transcranial magnetic stimulation, a non-invasive brain stimulation technique, to help understand how the brain represents predictable and unpredictable information.

Supervisor(s): Dominic Tran
Prerequisites: First year units in Psychology or Neuroscience
Maximum number of places available: 4
Project Location: Camperdown Campus
Final assessment: Project presentation, 5-10 minutes
Contact: mailto:minh.d.tran@sydney.edu.au

PSYC03: The psychology behind affirmative consent.

Globally, guilty verdicts in sexual assault trials are notoriously low (Tidmarsh & Hamilton, 2020), nationally, only 13% of sexual assault cases have resulted in a guilty verdict (NSW Criminal Court Statistics, 2021). To overcome the challenges, NSW introduced Affirmative Consent Laws in 2022 in NSW where consent must be given freely and voluntarily (Part 3, Division 10, Subdivision 1A of the Crimes Act 1900).

The aim of this project is to get a better understanding how factors- such as schemas, expectations and adherence to rape myths- affect the acceptance and application of affirmative consent laws. Then to use these findings to subsequently design programs to educate prospective jurors assigned to a sexual assault cases.

Supervisor(s): Celine van Golde
Prerequisites: Introductory psych courses, comfortable withcomputers and basic statistics
Maximum number of places available: 2
Project Location: Brennan MacCallum Building (A18)
Final assessment: Project report, 1-2 pages
Contact: mailto: celine.vangolde@sydney.edu.au

PSYC04: Memory and interpretations of repeated ambiguous relationship interactions.

Intimate partner violence (IPV) is a prominent issue in Australia. While historically receiving far less research attention, non-physical abuse (e.g., emotional abuse) appears to be more widespread than physical or sexual IPV with 1 in 4 women and 1 in 6 men having experienced emotional abuse by a partner, compared to 1 in 6 women and 1 in 16 men who have experienced sexual or physical IPV.
However, nonphysical IPV behaviours, are less likely to be recognised as violence compared to physical behaviours, by the victim, by eyewitnesses, and even within the legal system. This project will investigate how people remember and interpret nonphysical IPV behaviours, and how we can ensure they are recognised as abuse.

Supervisor(s): Celine van Golde
Prerequisites: Introductory Psycholgy courses, comfortable with computer and basic statistics
Maximum number of places available: 2
Project Location: Brennan MacCallum building A18
Final assessment: Project report, 1-2 pages
Contact: mailto:celine.vangolde@sydney.edu.au

PSYC05: Attention to action: The influence of reward-related attention on choice.

In our daily lives, we are constantly faced with reward-related stimuli that seem to automatically grab our attention (e.g., fast food logos, alcohol advertisements, social media). This project investigates these involuntary attentional biases influence our decision-making processes. Using eye-tracking technology, we will monitor participants' attention during a decision task, aiming to understand the cognitive mechanisms that drive both everyday choices and potentially addictive and compulsive behaviours.

Supervisor(s): Daniel Pearson
Prerequisites: First year Psychology units; comfortable with computers and statistical analysis (including t-tests and ANOVAs); an interest in cognitive science and psychology
Maximum number of places available: 1
Project Location: Camperdown Campus, University of Sydney
Final assessment: Project presentation, 5-10 minutes
Contact: mailto:daniel.pearson@sydney.edu.au

PSYC06: Visual attention in young people, old people, and people with dementia.

We rely on the perceptual part of our brains to parse the world into meaningful events and to keep track of them, particularly in busy scenes such as when driving a car or crossing the street. But certain aspects of these functions remain mysterious. Recently it was discovered that a new index of visual attention capacity declines precipitously with age. In this project you will test young and old people in a behavioral experiment involving keeping track of moving objects. The results will probe spatial and temporal sensory interference to provide insights into the nature of the ability's decline with age, and provide constraints on theories of normal visual cognition.

Supervisor(s): Alex Holcombe
Prerequisites: Comfortable with computers and interacting with people (because you'll be involved in testing them)
Maximum number of places available: 2
Project Location: Camperdown campus, University of Sydney
Final assessment: Project report, 1-2 pages
Contact: mailto:alex.holcombe@sydney.edu.au

PSYC07: Enhancing customer engagement with digital safer gambling tools.

Although most people who gamble do so without any negative consequences, a proportion of people experience mild to moderate harms. Digital resources exist and are being developed to help prevent severe gambling problems. However, it is difficult to encourage people to engage with these tools.
This project will use qualitative and quantitative methods with the aim of enhancing efforts to assist people at-risk of developing gambling harms use digital resources and increase lower-risk gambling behaviours.

Supervisor(s): Sally Gainsbury
Prerequisites: psychology, statistics or qualitative analysis,
Maximum number of places available: 7
Project Location: Brain and Mind Centre
Final assessment: Project presentation, 5-10 minutes
Contact: mailto:sally.gainsbury@sydney.edu.au

PSYC08: Exploring inhibitory control using transcranial magnetic stimulation

Inhibitory control refers to our ability to suppress or cancel learned actions when they are no longer appropriate. Deficits in inhibitory control are linked with a range of psychopathological disorders including addiction and OCD. Transcranial magnetic stimulation (TMS) can be used to measure neural activity in the motor networks of the brain. This project will use computer tasks measuring inhibitory control in combination with TMS to study the underlying cognitive and neural processes involved in stopping an action. The project will help to understand how our attempts to inhibit actions are successful in some situations and unsuccessful in others.

Supervisor(s): Evan Livesey
Prerequisites: Undergraduate Psychology and/or Neuroscience is helpful but not necessary
Maximum number of places available: 4
Project Location: Top South Badham Building, Griffith Taylor Building

Final assessment: Project presentation, 5-10 minutes
Contact: mailto:evan.livesey@sydney.edu.au

PSYC09: The role of disagreement in discrimination.

The student will run a(n) (online) study on whether humans discriminate more against another individual that disagrees versus agrees with them on seemingly irrelevant topics (e.g., the amount of dots on a screen, the length of two lines, the beauty of paintings,...). The student will have to adapt computer code in JSPsych/Python to develop an experimental variation on an existing online experiment. They will gain experience on experimental design, coding, online data collection, data-analysis and the broader topic of discrimination.

Supervisor(s): Eliane Deschrijver
Prerequisites: Only students that can code in C++, Python, JSPsych, Javascript or similar programming languages are eligible for this position. The student should be comfortable with statistical analysis in SPSS or R.programming
Maximum number of places available: 2
Project Location: School of Psychology
Final assessment: Project report, 1-2 pages
Contact: mailto:eliane.deschrijver@gmail.com

PSYC10: The meaning of quality of life.

This project will examine a snapshot of current literature to determine how the term "quality of life" is used in research. Previous research has demonstrated great diversity in how quality of life is defined and operationalised in health research, and there is a need for conceptual clarity so that different researchers can communicate clearly. This has serious implications because of the contexts in which the concept is invoked, e.g., evaluating health care interventions and in health economic decisions. This project will take a snapshot of how quality of life is defined over a short period but across literatures.

Supervisor(s): Daniel Costa
Prerequisites: An interest in theoretical and methodological issues in psychology; ability to search peer-reviewed literature and synthesise results.
Maximum number of places available: 1
Project Location: On campus / remote
Final assessment: Project report, 1-2 pages
Contact: mailto:daniel.costa@sydney.edu.au

PSYC11: Metacognition across the lifespan.

Metacognition, i.e., thinking about thinking, is critical for learning, reasoning, and decision-making. This project will examine how metacognition develops in children, and its role in cognitive performance in adults. Your role will include reviewing literature, designing experimental materials, and collecting and analyzing data.

Supervisor(s): Micah Goldwater
Prerequisites: No absolute prereq's, but preference for computer coding skills, and experience working with children. Though an individual can just be involved with the adult side of the project if they have no experience with kids.
Maximum number of places available: 3
Project Location: Brennan MaCacllum building, a mix of remote work and in person work
Final assessment: Project report, 1-2 pages
Contact: mailto:micah.goldwater@sydney.edu.au

PSYC12: How do couples remember an event?

This project is at the intersection of forensic psychology and social psychology and is supervised by Celine van Golde and Rebecca Pinkus. This project investigates whether romantic relationship power dynamics influence misinformation acceptance and psychological wellbeing after members of a couple witness, remember, and discuss an event. The project involves recruiting romantic couples (field work) and conducting an experiment in the lab (Griffith Taylor Building, Camperdown Campus).

Students will help analyse the videorecorded interactions between couples generated in this project.

Supervisor(s): Rebecca Pinkus
Prerequisites: Comfortable interacting with members of the community; hands on lab experience; interest in learning how to code videorecorded interactions; completed either of the PSYC1 units
Maximum number of places available: 2
Project Location: Camperdown Campus; Field work
Final assessment: Project report, 1-2 pages
Contact: mailto:rebecca.pinkus@sydney.edu.au

PSYC13: Researching emotion regulation strategies in romantic couples.

In this project you will work in pairs or small groups recruiting couples in public settings (e.g., parks) to take part in an experiment. You will help to run the experiment where one member of the couple faces a challenge and the other is instructed to help them. We are interested in how partners regulate each other's emotions in this situation. This study will involve fieldwork (working off-campus) and interacting with the public. You will be jointly supervised by both Dr Rebecca Pinkus and A/Prof Carolyn MacCann. As a secondary focus, this project may involve coding video footage from prior studies, preparing ethics applications, conducting literature reviews or assisting with systematic review and meta-analysis projects.

Supervisor(s): Carolyn MacCann
Prerequisites: Good interpersonal skills (comfortable interacting with the public and working in small groups)
Maximum number of places available: 7
Project Location: Mix of Camperdown campus + fieldwork + remote work from home
Final assessment: Project report, 1-2 pages
Contact: mailto:carolyn.maccann@sydney.edu.au

PSYC14: Forensic Psychology: The Dark Side of Relationships.

Manipulation, lying and gaslighting are things we commonly see in bad relationships. This project investigates these phenomena in three separate, but related studies. In study 1, student interns will help code data for a mega-analysis investigating adult memory for crimes that occur repeatedly (such as domestic violence). In study 2, student interns will code video footage of people discussing an event they experienced together, during which one person tries to convince the other person that their memory of the event is wrong. Similarly, in study 3, student interns will code video footage of people lying or telling the truth about their life stories. Interns will get the chance to work with academics in forensic psychology (Helen Paterson and Lillian Darke) and a practicing forensic psychologist (Mathew Gullotta).

Supervisor(s): Helen Paterson
Prerequisites: First year Psychology; An interest in Forensic Psychology
Maximum number of places available: 6
Project Location: Brennan MacCallum, Camperdown campus
Final assessment: Project report, 1-2 pages
Contact: mailto:helen.paterson@sydney.edu.au

PSYC15: The relationship between death anxiety and sleep.

This systematic review will explore the relationship between death anxiety (i.e. fear of one's own death or deaths of others), and sleep quality. It will aim to assess whether death anxiety is associated with poorer sleep quality, nightmares, and sleep disorders (e.g. insomnia). Participating in the project will involve screening papers for inclusion in the final review.

Supervisor(s): Rachel Menzies
Prerequisites: An interest in clinical psychology and/or mental health
Maximum number of places available: 2
Project Location: Camperdown campus (can be completed remotely)
Final assessment: Project presentation, 5-10 minutes
Contact: mailto:rachel.menzies@sydney.edu.au

PSYC16: Do open text survey responses reflect an empirically-derived conceptual model of abortion stigma?

This project involves analysis of over 900 open-text survey responses about abortion in Australia and contributes to the testing of new empirically derived models of abortion stigma. Results will provide insight into peoples' experiences and perspectives of abortion and stigma, survey completion, and abortion-related research, and the validity of models of abortion stigma in Australia. Students will gain skills in qualitative analysis, data triangulation, and development of conceptual models.

Supervisor(s): Haryana Dhillon
Prerequisites: There are no pre-requisite skills, however interest in stigma, reproductive health, and qualitative data analysis would be helpful. Flexible working options are available
Maximum number of places available: 4
Project Location: Griffith Taylor Building, Camperdown Campus
Final assessment: Project presentation, 5-10 minutes
Contact: mailto:haryana.dhillon@sydney.edu.au

PSYC17: What is known about abortion in Australia? A systematic review of the qualitative literature.

Ensuring quality abortion care in Australia is required to meet national and international goals and standards of care. Following review guidelines, this study will systematically identify, review, synthesise, and assess the qualitative evidence about abortion in Australia to provide evidence-based recommendations for future research, practice, and policy. Results will provide insight into what is and is not known about abortion, similarities and differences in abortion-related experience, quality of qualitative evidence available in Australia, and what is needed from research, policy, and practice to secure quality abortion case in Australia. Students will gain valuable research and graduate skills in systematic identification, collection, and assessment of evidence.

Supervisor(s): Haryana Dhillon

Prerequisites: No prerequisite skills are needed. Experience and/or interest in critical appraisal skill development, organised and collaborative work, and/or reproductive healthcare is desirable. Flexible working options are available.
Maximum number of places available: 4
Project Location: Griffith Taylor Building, Camperdown Campus
Final assessment: Project presentation, 5-10 minutes
Contact: mailto:haryana.dhillon@sydney.edu.au

PSYC18: What did the Australian media say about abortion in response to the overturn of Roe v Wade and sequential advancements of abortion care in Australia?

The media has a role in shaping how abortion is positioned and understood. This project will review the print media in Australia about abortion from May 2022 and map findings to world events. Findings will provide insight into abortion-related discourse in Australia at the time of regression of abortion-related laws in the USA (i.e., overturn of Roe v Wade and Dobbs v Jackson) and the following after. Results will address evidence gaps in structural-level abortion information, Australian abortion discourse, and how events and discourse in the USA relate to events and discourse in Australia. Students will gain skills in data collection, qualitative analysis, and content knowledge.

Supervisor(s): Haryana Dhillon
Prerequisites: There are no prerequired skills or knowledge, however interest in media, structural-level stigma, and reproductive health is favourable. Flexible working options are available.
Maximum number of places available: 4
Project Location: Griffith Taylor Building, Camperdown Campus
Final assessment: Project presentation, 5-10 minutes
Contact: mailto:haryana.dhillon@sydney.edu.au

PSYC19: Measuring depth of visual suppression.

We have developed a new method to measure how deeply a visual image in eye is suppressed from visibility by a conflicting image presented in the other eye. We are still developing the method and have a number of experimental manipulations to test. The summer student would learn how to run these tests on human subjects and gain skills in analysing and presenting data and some elementary computer coding skills. The project will finish with a presentation by the student to the lab summarising their role in the project.

Supervisor(s): David ALAIS
Prerequisites: Students should have: a strong interest in visual perception; a good understanding of statistical tests; be comfortable with computers and data analysis; have a deep curiosity to understand perceptual processes.
Maximum number of places available: 2
Project Location: School of Psychology (Griffith-Taylor building)
Final assessment: Project presentation, 5-10 minutes
Contact: mailto:David.alais@sydney.edu.au

PSYC20: Neural mechanisms of predictive coding revealed using EEG and gaze contingent displays

Predictive coding is how our brain predicts what it expects to see, using past experiences to understand and interpret new information. A mechanistic implementation of predictive coding has been notoriously difficult to study in the brain. In this project, we will combine gaze-contingent eye tracking, brain recordings (electroencephalography or EEG), and machine learning analysis techniques to test key predictions of the predictive coding framework on neural data. The outcome of the project will elucidate the neural mechanisms underlying predictive coding in the human brain.

Supervisor(s): Thomas Carlson
Prerequisites: Student will need to have strong technical and programming skills (preferably MATLAB). A background in Psychology or Neuroscience will be helpful, but not required.Neuroscience

Maximum number of places available: 2
Project Location: School of Psychology, Griffith Taylor Building
Final assessment: Project presentation, 5-10 minutes
Contact: mailto:Thomas.Carlson@sydney.edu.au

School of Life and Environmental Sciences

SOLE01: Nutritional strategies to promote sustainable chicken meat production.

This project investigated how climate factors influence feed grain quality in poultry and how we can reduce usage of imported raw materials in poultry diet without compromising growth performance. Students will have the opportunity to conduct chicken feeding studies on our research farm based at Camden. If you are curious and passionate about agriculture, animal science and production, this opportunity will enable you to gain knowledge in animal husbandry, industry insights, poultry nutrition and welfare.

Supervisor(s): Sonia Liu
Prerequisites: happy to handle chickens, interested in animal agriculture and basic understanding of statistics
Maximum number of places available: 5
Project Location: Camden Campus
Final assessment: Project report, 1-2 pages
Contact: mailto:sonia.liu@sydney.edu.au

SOLE02: Mechanistic basis of nutrient transport in the shark placenta.

This project will leverage histological and genetic techniques to determine the mechanisms by which nutrients are transported in the shark placenta. This project would suit students interested in molecular biology, genetics, and marine biology, with some experience in histology.

Supervisor(s): Camilla Whittington
Prerequisites: Experience with histological techniques
Maximum number of places available: 1
Project Location: Camperdown Campus
Final assessment: Project report, 1-2 pages
Contact: mailto:camilla.whittington@sydney.edu.au

SOLE03: Feeding Behaviour of Crown of Thorns Seastar.

The crown of thorns seastar (COTS) is a coral predator, with outbreaks leading to the devastating loss of coral across Indo-Pacific reefs. This project will involve measuring and analysing the amount and type of coral that COTS is eating, from surveys collected across different seasons from One Tree Island on the Great Barrier Reef, where a low density population of COTS has been living for the past 30 years.

Supervisor(s): Shawna Foo
Prerequisites: Comfortable with computers and statistical analysis, familiarity with R and Image J.
Maximum number of places available: 1
Project Location: A11, A12
Final assessment: Project report, 1-2 pages
Contact: mailto:shawna.foo@sydney.edu.au

SOLE04: Does protection confer greater stability and resilience of coral reef diversity to environmental disturbance?

Marine Protected Areas (MPAs) have been implemented worldwide to preserve biodiversity. Whether protection from direct human impacts has the capacity to enhance the resilience of marine communities to environmental disturbance is unclear, partly due to the limitations of traditional analyses of turnover, and the lack of available long-term data. This project will analyse the Great Barrier Reef long-term

monitoring program data to assess stability, resistance to, and recovery from storm, cyclone, and heatwave events in tropical fish communities.

Supervisor(s): Amanda Pettersen
Prerequisites: Experience using R, in particular data wrangling. Training will be provided in analysis.
Maximum number of places available: 1
Project Location: Camperdown Campus and remote
Final assessment: Project report, 1-2 pages
Contact: mailto:amanda.pettersen@sydney.edu.au

SOLE05: Investigating variation in the thermal tolerance of kelp species in New South Wales.

Habitat-forming kelp of the Great Southern Reef support our economy and way of life, yet are under threat due to human mediated stressors, including climate change. Within-species variation in thermal responses (e.g., southern populations experience cooler temperatures than northern populations) means that populations have likely evolved differences in the thermal sensitivity of their carbon balance, to optimise growth and survival under local conditions. This project will experimentally measure the thermal physiology of early life stages of kelp species and populations under controlled laboratory conditions.

Supervisor(s): Amanda Pettersen
Prerequisites: Confident swimmer/snorkeler, physical work in the subtidal, attention to detail needed to undertake laboratory physiology assays.
Maximum number of places available: 1
Project Location: Sydney Institute of Marine Science
Final assessment: Project report, 1-2 pages
Contact: mailto:amanda.pettersen@sydney.edu.au

SOLE06: Solving Metabolic Disease via Data Analysis.

Systems biology has evolved to study complex diseases like cancer, diabetes and cardiovascular disease. This requires collection of large amounts of omics data from tissues or blood and use of quantitative methods to identify key disease regulators or drivers. This project will explore the use of Biological Data Analysis to study insulin resistance, one of the earliest defects found in individuals with metabolic diseases like Type 2 diabetes.

Supervisor(s): David James
Prerequisites: -
Maximum number of places available: 2
Project Location: Charles Perkins Centre -Building D17, Camperdown
Final assessment: Project presentation, 5- 10 minutes
Contact: mailto:david.james@sydney.edu.au

SOLE07: Understanding leaf shape variation.

Plant leaves come in a huge variety of sizes and shapes. We are studying the genetic regulation of leaf shape. We work with Arabidopsis thaliana and a closely related species Cardamine hirsuta. We are able to use a broad range of genetic and molecular tools to investigate details of how a class of transcription factors control leaf shape. This project will investigate leaf morphology and cellular details in a number of mutants with leaf shape changes.

Supervisor(s): Mary Byrne
Prerequisites: Knowledge of genetics; comfortable using a microscope; interest in plant biology
Maximum number of places available: 1
Project Location: LEES Building F22 Camperdown Campus
Final assessment: Project report, 1-2 pages
Contact: mailto:mary.byrne@sydney.edu.au

SOLE08: mito-nuclear coevolution in the genomes of native bees.

In this project you will analyse the nucleotide sequences of mitochondrial genomes and nuclear genomes from native Australian bees in the genus Tetragonula to better understand how the two genomes co-evolve. Mito-nuclear interactions can have profound consequences for cell function, but it new research suggests they can also impact macro population-level processes, such as the formation of new species. Native stingless bees are an ideal model for exploring these questions.

Supervisor(s): Ros Gloag
Prerequisites: comfortable with viewing and analysing nucleotide and protein sequences
Maximum number of places available: 2
Project Location: LEES Building F22 Camperdown Campus
Final assessment: Project report, 1-2 pages
Contact: mailto: ros.gloag@sydney.edu.au

SOLE09: Ecological relationship between native stingless bees and fungi.

Bees are famously flower-feeders, that collect pollen and nectar to feed themselves and their young. Some bees however also have complex relationships with fungi, which may be an additional food source. In this project, you will establish if and when native Australian stingless bees forage for fungi using a combination of techniques including microscopy, field observations and behavioural experiments.

Supervisor(s): Ros Gloag
Prerequisites: interest in insects; willing to handle native stingless bees (they can't sting!)
Maximum number of places available: 2
Project Location: LEES F22 Level 5 (BEE Lab) and beehouse, Camperdown
Final assessment: Project report, 1-2 pages
Contact: mailto:ros.gloag@sydney.edu.au

SOLE10: Deciphering the antimicrobial activity of native Australian stingless bee honey.

Tetragonula carbonaria, a native Australian stingless bee, produces honey with a distinctive flavour, unique chemical composition, and notable antimicrobial properties. Other hive products made by T. carbonaria including stored pollen and propolis (a blend of plant resins and beeswax) also exhibit remarkable antimicrobial power. In this project we will investigate the underlying mechanisms behind this antimicrobial activity by testing hive products against bacteria and fungi, and analysing key chemical properties including hydrogen peroxide, phenolics, and antioxidants. These results will help us understand both the potential therapeutic benefits of T. carb hive products and their ecological role in bee health.

Supervisor(s): Kenya Fernandes
Prerequisites: Experience working with and handling microorganisms, ideally in a PC2 environment + second-year first semester microbiology unit
Maximum number of places available: 2
Project Location: F22 LEES, Camperdown
Final assessment: Project report, 1-2 pages
Contact: mailto:kenya.fernandes@sydney.edu.au

SOLE11: The plants around us: using technology-led approaches to understand plant-animal interactions.

By understanding the plants growing around us we gain insights into how ecosystems work. This project explores the floral diversity in key plant families of the Sydney region using technology-led approaches (i.e., CT-generated 3D objects) to create shareable online content highlighting the importance of floral morphology in plant-animal interactions. Selection of plants for examination in this project will privilege those where First Nations namings are known and those used across the life science curriculum.

Supervisor(s): Rosanne Quinnell
Prerequisites: An interest in plant-animal interactions.
Maximum number of places available: 2

Project Location(s): Camperdown
Final assessment: Project report, 1-2 pages
Contact: mailto:rosanne.quinnell@sydney.edu.au

SOLE12: Developing science-based simulation for COVID infections.

The ability to create realistic simulations based on scientific evidence has advanced dramatically with the rapid progress in computational power. Simulations offer many advantages from safety, cost and time efficiency, ethics to convenience. In this project, you will contribute to developing a simulator that models viral transmission under different scenarios. The simulator will be used to enhance the understanding of viral ecology to first year biology students with potential roll out to the wider community and be turned into an online and/or card game.

Supervisor(s): Ann Kwan
Prerequisites: Students who intend to major in BCMB/BIOL/MICRO and have experience with lab data generators featured in 1st or 2nd year BIOL/BCMB courses (e.g., BIOL1997, BCMB2). Desirable: Some programming experience.
Maximum number of places available: 2
Project Location: Carslaw and G08, Camperdown
Final assessment: Project report, 1-2 pages
Contact: mailto:ann.kwan@sydney.edu.au

SOLE13: Developing novel lead molecules to fight antibiotic resistance.

Antibiotic resistance is a major global health issue. However, there have been few new classes of antibiotics introduced in the last few decades. Our project aims to tackle this issue by developing novel classes of broad- and narrow-spectrum antibiotics against bacterial proteins that are essential or have been implicated in virulence. There are different classes of molecules being developed and you will be assigned to an aspect of the project depending on your background and interest.

Supervisor(s): Ann Kwan
Prerequisites: Students who intend to major in BCMB/MICRO and have prior wet laboratory experience in molecular biology and protein chemistry.
Maximum number of places available: 1
Project Location: G08
Final assessment: Project report, 1-2 pages
Contact: mailto:ann.kwan@sydney.edu.au

SOLE14: Finding our missing Christmas Beetles!

Christmas Beetles (Anoplognathus spp) used to be a beautiful, iridescent part of the holiday season. Over the years, however, Christmas beetle populations appear to have declined dramatically. This project aims to find out the cause of the Christmas beetle declines so that we can bring back these beautiful beetles!

Supervisor(s): Tanya Latty
Prerequisites: Must be willing to handle insects (Christmas beetles are adorable and harmless:). Must be able to sample at night (with supervisors). Must be comfortable occasionally taking public transit to meet us at sampling sites. Previous experience with insects/biology not required, but must be willing to learn!
Maximum number of places available: 4
Project Location: This project will involve using light traps to catch Christmas beetles in different regions of Sydney. Sampling will occur AT NIGHT (dusk- 11 pm at the latest). Non-sampling days will be based in the Heydon Laurence building (A08)
Final assessment: Project presentation, 5- 10 minutes
Contact: mailto:tanya.latty@sydney.edu.au

SOLE15: Buzzworthy Bites: Pollinator Nutrition in Urban Landscapes

Bees rely on flowers for all of their nutritional needs. However, not all flowers are nutritionally equal. This project will explore the 'nutritional landscape' of urban greenspaces, by determining the nutritional quality of pollen and nectar.

Supervisor(s): Tanya Latty
Prerequisites: Bees rely on flowers for all of their nutritional needs. However, not all flowers are nutritionally equal. This project will explore the 'nutritional landscape' of urban greenspaces, by determining the nutritional quality of pollen and nectar.
Maximum number of places available: 3
Project Location: Heydon Laurence (A08); Greenspaces in inner Sydney
Final assessment: Project presentation, 5- 10 minutes
Contact: mailto:tanya.latty@sydney.edu.au

SOLE16: Machine learning to quantify biomass from multispectral Drone imagery.

Remote sensing of biomass is crucial for agricultural production and carbon sequestration. Drone imagery can offer insight in fine scale variation that fills in coarse scale satellite data. We have collected multiple drone survey and ground truth data. The project would work on processing the drone data and building a machine learning model to predict biomass using Python.

Supervisor(s): Willem Vervoort
Prerequisites: Python coding
Maximum number of places available: 1
Project Location: Bldg. C81, Biomedical Bldg., Eveleigh, Darlington
Final assessment: Project presentation, 5- 10 minutes
Contact: mailto:willem.vervoort@sydney.edu.au

School of Mathematics and Statistics

MATH01: New data science approaches for single cell spatial genomics

Recent developments in single cell RNA-sequencing and spatially resolved genomics (e.g., seqFISH, 10X Visium) have resulted in immense datasets corresponding to hundreds of thousands of observed cells and thousands of measured features. The overarching goal is to develop new data science approaches to addressing questions in biology and create new algorithms for understanding these data. There are opportunities to build capacity in terms of computational modelling, effective data visualisation and interaction, and software scalability.

Supervisor(s): Shila Ghazanfar
Prerequisites: DATA2002/DATA2902
Maximum number of places available: 4
Project Location: Camperdown (Carslaw, CPC)
Final assessment: Project presentation, 5-10 minutes
Contact: mailto:shila.ghazanfar@sydney.edu.au

MATH02: Scaling laws in Urban data from Australia.

This project will combine mathematical models, computational techniques, and statistical methods to investigate the existence of universal statistical laws in data of Australian cities. The most famous of such as laws is the so-called Zipf's law of cities, and the goal is to investigate the dynamics of the population size in Australian cities that resulted in its two largest cities having similar sizes. The project will also consider urban-scaling laws, expanding and building on the models and results of Ref. [1], and considering new types of data (e.g., census, geo-located twitter data) and mathematical methods (e.g., new spatial interactions, new MCMC inference methods).

Supervisor(s): Eduardo Altmann

Prerequisites: Knowledge of a programming language and at least basic knowledge of Python. First year Calculus and Statistics or Data Science.
Maximum number of places available: 2
Project Location: Camperdown Campus, Carslaw Building
Final assessment: Project Presentation, 5 – 10 minutes
Contact: mailto:eduardo.altmann@sydney.edu.au

MATH03: Exploring Statistical Models for Animal Behaviour Analysis.

This project offers a unique opportunity to decipher the underlying patterns and motivations driving animals' actions during the warm months. By employing cutting-edge statistical techniques, you will uncover hidden insights from observational data, shedding light on factors influencing animal behaviour. Immerse yourself in the natural world while honing your analytical skills and contributing to a deeper understanding of the fascinating behaviours that unfold in the animal kingdom during summertime.

Supervisor(s): Clara Grazian
Prerequisites: Statistical theory (at least STAT2011)
Maximum number of places available: 1
Project Location: Sydney, Camperdown Campus
Final assessment: Project report, 1-2 pages
Contact: mailto:clara.grazian@sydney.edu.au

MATH06: Data-intensive science to understand the molecular aetiology of disease.

Biotechnological advances have made it possible to monitor the expression levels of thousands of genes and proteins simultaneously promising exciting, ground-breaking discoveries in complex diseases. This project will focus on the application and/or development of statistical and machine learning methodology to analyse a high-

dimensional biomedical experiment. Our lab works on projects spanning multiple diseases including melanoma, acute myeloid leukemia, cardiovascular disease, organ transplant, multiple sclerosis and HIV.

Supervisor(s): Ellis Patrick
Prerequisites: Completion of DATA2X02 or equivalent
Maximum number of places available: 4
Project Location: The School of Mathematics and Statistics (Carslaw building) and/or The Westmead Institute for Medical Research and/or remote.
Final assessment: Project presentation, 5-10 minutes
Contact: mailto:ellis.patrick@sydney.edu.au

MATH07: Analytics for Randomized Controlled Trials in Hypertension Management.

This project aims to use longitudinal blood pressure (BP) progression data sets to make the optimal treatment decision. The BP progression is modelled by a Brownian motion. We will use simulation to estimate the potential impact of the model.

Supervisor(s): Qiuzhuang Sun
Prerequisites: Comfortable with computers and statistical analysis; familiarity with R or Python
Maximum number of places available: 5
Project Location: Sydney
Final assessment: Project report, 1-2 pages
Contact: mailto:qiuzhuang.sun@sydney.edu.au

MATH08: Post-quantum cryptography.

Quantum computers are expected to break currently used secure public-key algorithms. This project will investigate ideas underlying proposed new "quantum-proof" algorithms related to mathematical structures.

Supervisor(s): Nalini Joshi

Prerequisites: Interest in symbolic mathematical computation, second-year mathematics units, interest in learning magma and cryptography.
Maximum number of places available: 2
Project Location: University of Sydney, Camperdown campus
Final assessment: Project report, 1-2 pages
Contact: mailto:nalini.joshi@sydney.edu.au

MATH09: Software development for measurement error correction.

Measurement error is ubiquitous in big data and can seriously distort relationships among variables in the dataset. Hence, it is imperative to correct measurement errors to gain appropriate insights from the data. A recently developed method, called simulation-selection-extrapolation, is able to correct measurement errors in a wide range of settings, especially in settings with a large number of variables in the dataset. The project aims to develop statistical packages for this methodology, making it more accessible to a wide range of audiences and practitioners. Through the project, students will gain knowledge about advanced statistical modelling and have experience developing high-quality software.

Supervisor(s): Hoang Linh Nghiem
Prerequisites: Skills: Proficient with programming in R or Python; intermediate knowledge about statistical modelling, preferably having taken STAT3022 and/or STAT/DATA3888 or an equivalent unit.
Maximum number of places available: 2
Project Location: Sydney or online
Final assessment: Project report, 1-2 pages
Contact: mailto:linh.nghiem@sydney.edu.au

MATH10: An approximate model of the Levitron.

The Levitron is a magnetic symmetric top, that can levitate while spinning. There is an exact theory for its motion, and various approximate simpler models. The goal of this project is to derive an approximate simpler model from the exact model, and compare them analytically and with numerical experiments.

Supervisor(s): Holger Dullin
Prerequisites: Ideally students will have done MATH3977
Maximum number of places available: 2
Project Location: Carslaw Building Camperdown
Final assessment: Project report, 1-2 pages
Contact: mailto:holger.dullin@sydney.edu.au

MATH11: Methods towards precision medicine.

Over the past decade, new and more powerful -omic tools have been applied to the study of complex diseases such as heart attacks 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 computational methods that help identify disease pathways and deliver better prediction of outcomes. This project could also investigate whether it is possible to establish associations between features extracted from imaging data and cellular measurements from a large cohort of individuals.

Supervisor(s): Jean Yang
Prerequisites: Comfortable with computers and statistical analysis, familiarity with R, assume DATA2002 knowledge.
Maximum number of places available: 4
Project Location: CPC or Carslaw, Camperdown
Final assessment: Project report, 1-2 pages
Contact: mailto:jean.yang@sydney.edu.au

MATH12: Imaging-omics for precision medicine in CAD.

In the ongoing battle against diseases like heart attacks, medical technology has seen significant advancements, equipping clinicians with innovative diagnostic tools. Alongside this, there's a growing demand for the application of machine learning techniques to extract meaningful insights from this data. The aim of this project is to explore potential associations between features derived from imaging data and cellular measurements across a vast number of individuals using machine learning approaches. Ultimately, this could lead to the identification of key features from either imaging or multi-omics modalities, enhancing our ability to predict Coronary artery disease (CAD) outcomes.

Supervisor(s): Jean Yang
Prerequisites: Comfortable with computers and statistical analysis, familiarity with R, assume DATA2002 knowledge.
Maximum number of places available: 4
Project Location: CPC, Camperdown
Final assessment: Project report, 1-2 pages
Contact: mailto:jean.yang@sydney.edu.au

MATH13: Translation surfaces and origami.

Translation surfaces are surfaces obtained by gluing sides of polygons together with translations. They hold a unique position at the crossroads of topology, geometry and dynamics, and are related to the study of billiard trajectories.
The study of the space of these surfaces, their moduli space, is a rich area of current research.
Questions include understanding deformations of these surfaces: can one continuously deform a given translation surface into another? Can this be achieved by applying two-by-two matrices on the polygons?
Origami are special cases of translation surfaces. They are surfaces obtained by gluing unit squares along their edges. Many questions then acquire a combinatorial flavour and are related to the study of the symmetric group.
The aim of this project is to get a glimpse of this research domain by focusing on these simple objects that still hold many mysteries.

Supervisor(s): Thomas Le Fils

Prerequisites: Linear algebra (MATH2922 or MATH2022). Desirable knowledge of basic group theory (symmetric group).
Maximum number of places available: 2
Project Location: University of Sydney (Quadrangle, SMRI)
Final assessment: Project presentation, 5-10 minutes
Contact: mailto:thomas.fils@sydney.edu.au

MATH14: Identifying gaps in curriculum alignment.

While robust curriculum design seeks for the constructive alignment of all learning activities and assessments, it is easy for gaps to emerge between what is explicitly taught and assessed, especially in a dynamic environment where there is a large cohort, team teaching and a culture of continual improvement. How can we identify possible discrepancies in curriculum alignment?

Supervisor(s): Di Warren
Prerequisites: HD/D in DATA1001/1901; Or CR+ in DATA2002/2902
Maximum number of places available: 2
Project Location: University of Sydney, Camperdown
Final assessment: Project report, 1-2 pages
Contact: mailto:diana.warren@sydney.edu.au

MATH15: What are isomonodromic deformations?

Some differential equations have the incredible property that their solutions can be fully determined by the associated geometry. In this project you will first explore the cubic surfaces related to such differential equations. Then we understand how to deform the equations such that the cubic surface remains invariant. Such deformations are called isomonodromic deformations, and have far reaching implications in mathematics and physics.

Supervisor(s): Harini Desiraju

Prerequisites: Basic knowledge of complex variables in needed.
Maximum number of places available: 3
Project Location: Online and in person
Final assessment: Project presentation, 5-10 minutes
Contact: mailto:harini.desiraju@sydney.edu.au

MATH16: HEUN POLYNOMIALS AND HYPERBOLIC POLYGONS.

The Heun equation is a differential equation with deep connections to hyperbolic geometry. Any solution to the Heun equation gives rise to an angle preserving map from the upper half-plane to a hyperbolic polygon. In this project we will study the polygons corresponding to the simplest solutions of the Heun equation, the fascinating Heun polynomials.

Supervisor(s): Harini Desiraju, Pieter Roffelsen
Prerequisites: MATH2023, some experience with numerical plotting is desirable but not necessary
Maximum number of places available: 3
Project Location: Online and in person
Final assessment: Project report, 1-2 pages
Contact: mailto:harini.desiraju@sydney.edu.au

MATH17: Monodromy and cubic surfaces.

Monodromy encodes how objects change as they move around singularities. When the objects in question are solutions of certain differential equations, this gives rise to beautiful and very classical surfaces known as cubic surfaces. It is a famous result in geometry that a cubic surface contains precisely 27 lines (counting multiplicity). In this project we study lines on these surfaces and what they can tell us about monodromy.

Supervisor(s): Pieter Roffelsen
Prerequisites: MATH2023: Analysis or MATH3061: Geometry and Topology

Maximum number of places available: 2
Project Location: The School of Mathematics & Statistics, Camperdown
Final assessment: Project report, 1-2 pages
Contact: mailto:pieter.roffelsen@sydney.edu.au

Computer Science

COMP01: AI and Natural Language Processing for Healthcare.

Clinical notes contain key information about patients, but they are difficult to interpret. The style of writing is a challenge even for large language models (LLMs) like ChatGPT, because the writing is unlike the training data for LLMs (online text and books). This project is about developing an AI-based system for clinical coding: identifying key information in clinical notes.

Supervisor(s): Jonathan K. Kummerfeld
Prerequisites: Experience in Python (either through first year CS units or extensive experience elsewhere)
Maximum number of places available: 2
Project Location: Camperdown campus
Final assessment: Project presentation, 5-10 minutes
Contact: mailto:jonathan.kummerfeld@sydney.edu.au

COMP02: AI and Natural Language Processing: Collaborative Intelligence for Crowdsourcing.

Many AI systems rely on labelled data for training. Creating those resources is usually a laborious process performed by experts. For some tasks, methods have been developed for non-experts to label data, e.g. for identifying objects in images. This project aims to push the boundaries of what non-experts can do by taking advantage of AI. One directions is an adaptive labelling system, where people do most of the work at first, but then the system automatically shifts over time to use more AI input and less human input. The other direction is to create a human-AI collaborative system that can do perfect real-time speech recognition.

Supervisor(s): Jonathan K. Kummerfeld

Prerequisites Experience in Python (either through first year CS units or extensive experience elsewhere)

Maximum number of places available: 2

Project Location: Camperdown campus

Final assessment: Project presentation, 5-10 minutes

Contact: mailto:jonathan.kummerfeld@sydney.edu.au

Contact

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