UNIVERSITY OF AUCKLAND
Waipapa Taumata Rau
NEW ZEALAND

lpdp

PhD Opportunities for LPDP Scholars 2023

profiles.auckland.ac.nz

Contents

Explore a selection of PhD opportunities in the following areas:

The projects listed in this booklet are just a few of the many possible research projects suitable for doctoral study at the Auckland Bioengineering Institute at the University of Auckland. For information about other areas of active research in which it might be possible to undertake doctoral studies, see the following webpage:

- **Doctoral study in Bioengineering**

Project: Electrophysiology of menstruation; a multiscale modelling approach
Contractions of the uterus vary during the different phases of the menstrual cycle. These contractions are thought to facilitate the transport of sperm for egg fertilisation during the late follicular phase and to aid the menstruation process during menses. These contractions can also be a cause of pain during menses. Abnormalities in uterine contractions have been hypothesised to contribute to retrograde menstruation: the loss of menstrual debris out of the fallopian tube. Retrograde menstruation, in turn, is thought to be the root cause of endometriosis, a chronic disease affecting 1 in 9 women in which lesions form when endometrial-like cells grow outside the uterus. This project aims to: 1) Develop mathematical models for the activation of contractions in smooth muscle tissue of the uterus; 2) Model cell contraction within tissue using agent-based modelling approaches and explore the relationship between agent-based model results and continuum models of electrical patterns in the uterus; 3) Use the models to investigate normal and abnormal contractions in the uterus. Stretch goal: model the interaction between contractions and menstrual fluid.
Contact: Dr Claire Miller (claire.miller@auckland.ac.nz)
Keywords: mathematical modelling; computational modelling; women's health; endometriosis; menstruation and electrophysiology

Project: Advanced Deep Learning Methods for the Characterization and Prediction of Volumetric Growth Rates of Brain Tumours
Preoperative manual assessments of a brain tumour is a crucial step for pre-surgical planning. Meningiomas constitute approximately 35% of intracranial tumours managed by neurosurgeons. Understanding the exact characteristics of this type of brain tumour,

as well as estimating its growth rate, can improve the scientific knowledge of neurosurgeons and contribute towards optimal tumour management and intervention. There is currently a lack of research regarding the automatic prediction of meningiomas growth ratesa and few attempts have been focused on genetic characterization assessments.
This study aims to develop advanced technology, based on deep learning strategies, for the automatic prediction of tumour growth rate and the characterization of tumour features associated with the growth. We aim to use archived data from Auckland Hospital to develop automated algorithms for the prediction of meningiomas growth rate, and characterize associated contributing parameters, in a cohort of different ethnic participants (including Pākehā, Māori and Pasifika populations).
Explorations will provide novel insights into automatic assessments for volumetric growth patterns in intracranial meningiomas and answer the research question regarding the possibilities of predicting tumour growth rates associated with different ethnic groups. Such insights could be helpful for longitudinal surgical planning and/or prescribing certain medicine regimes.
Contact: Dr Hamid Abbasi (h.abbasi@auckland.ac.nz)
Keywords: brain tumour; meningiomas; deep learning; volumetric growth rate; computational modelling

Project: Hidden clocks – developing temporal EEG biomarkers for evolving hypoxic-ischemic brain injury using advanced machine learning techniques
Preterm babies have a high risk of brain injury after hypoxia-ischaemia (HI). Currently, we have no specific neuroprotection/neurorepair treatments for these infants. Development of effective treatments requires targeting the right phases of injury and biomarkers are needed to identify at-risk babies.
Building on our previous studies, this complimentary work aims to use data from preterm sheep models and human neonates to determine the changes in EEG waveforms over time, after an HI-insult, to establish temporal prognostic markers to precisely diagnose phases and severity of brain injury. This research will be the first comprehensive longitudinal assessment of evolving EEG waveforms and seizure-like activity in the preterm brain after an injurious HI insult, with comparison to a clinical database of EEG started early after birth. This novel work will provide key data for the development of current clinical diagnostic and prognostic monitoring, and an essential foundation of knowledge upon which we can then assess the effects of other common adverse events such as exposure to inflammation, and clinical treatments, including those for seizures. The project aims to validate automated algorithms that can rapidly inform clinical assessment and can be ultimately used in clinical practice.
Contact: Dr Hamid Abbasi (h.abbasi@auckland.ac.nz)
Keywords: EEG waveforms; machine learning; brain function; seizure; computational modelling

Project: Glucose control - from home to hospital and back again
In diabetes, glycaemic control is often based on sub-optimal one-size-fits-all approaches, so many receive acceptable care, but none receive optimal care. We can improve control using digital twins, capturing all relevant dynamics to personalise care.

Incorporating wearable device data, this project aims to develop a patient-specific digital twin model of glucose and insulin dynamics to provide robust glycaemic control during hospitalisation, and eventually for outpatients.

This is a fantastic opportunity to gain hands-on experience in digital twin modelling and automated identification methods to personalise these models, as well as to develop advanced control systems for optimising patient outcomes.
The project will include developing a clinical trial to test these methods, providing translational experience and potential for commercialisation. You will have the opportunity to spend time at the Auckland Bioengineering Institute with Dr Finbar Argus and at the University of Canterbury with Distinguished Professor Geoff Chase.
As a PhD student on this project, you will work with a team of experienced researchers to develop cutting-edge solutions to improve patient care, decrease morbidity and mortality, and get diabetes patients back into the comfort of their own homes, and out of - expensive to the taxpayer - hospital beds.
Contact: Dr Finbar Argus (finbar.argus@auckland.ac.nz)
Keywords: diabetes care; digital twins; glycaemic control; computational modelling; wearable devices

Project: Development of intelligent multimodal imaging analysis platform to predict stroke motor outcomes
Stroke is a leading cause of adult disability. Being able to predict motor recovery and outcomes soon after stroke could support clinicians to set appropriate goals for treatment and rehabilitation. This project will derive and train an automated artificial intelligence platform by using machine learning methods to identify lesions and features of the sensorimotor network and whole brain to classify patients according to expected stroke outcomes. This project has the potential to improve the quality and efficiency of rehabilitation. The clinical characteristics will be combined with acute imaging to make predictions for upper limb function and walking outcomes at 3 months post-stroke. We will derive the model using our large retrospective imaging and clinical dataset. The model will then be used to create and train a prediction tool using prospectively collected routine medical imaging data.
Preferred candidate: Experience in computer science, biomedical engineering, electronic engineering, mathematics, physics, computational neuroscience or related subject. Good programming skills in Matlab, C++, or Python. Strong experience in machine/deep learning and/or (medical) image analysis. Excellent writing and communication skills (in English).
Contact: Associate Professor Alan Wang (alan.wang@auckland.ac.nz)
Keywords: stroke; artificial intelligence; medical imaging; brain function

Project: Machine/deep learning in neuroimaging quantifications
We will develop innovative machine / deep learning algorithms for big data analytics, robust pooling and harmonization of neuroimaging data with varying acquisition protocols, and find new representations from a large cohort of neuroimaging data in order to classify diseases, predict disease progression and evaluate future recovery in neurological and psychiatric diseases. The major focus will be on MRI neuroimaging quantification in concussion, dementia, stroke, Parkinson's disease etc. We are looking for highly motivated research students for different kinds of research questions within the interdisciplinary field of machine / deep learning and neuroimaging data analysis.
Preferred candidate: Experience in computer science, biomedical engineering, electronic engineering, mathematics, physics, computational neuroscience, or related subject. Good programming skills in Matlab, C++, or Python. Strong experience in machine/deep learning and/or (medical) image analysis. Excellent writing and communication skills (in English).

Contact: Associate Professor Alan Wang (alan.wang@auckland.ac.nz)
Keywords: machine learning, neuroimaging, brain disease, MRI

Project: Development of intelligent magnetic stimulation with multiple targets
Neuroplasticity-based transcranial magnetic stimulation (TMS) is a non-invasive technique used for stroke rehabilitation. However, traditional TMS systems face limitations regarding the depth of penetration, the precision of the electric field, and only have one focal target at a time. We aim to develop a flexible temporal interference TMS helmet with multiple magnetic stimulation units which can be intelligently triggered/adjusted according to personalized brain impairments to achieve the most effective recovery outcomes. We will design an intelligent magnetic stimulation system including multiple coils with regulatable positions and angles. We will develop a software-controlled multi-port integrated energy converter to enable temporally interfering regulation for multiple load currents.
Our focus includes the investigation and design of an optimized array coil structure for temporal interference magnetic stimulation, optimizing magnetic stimulation coil cores and shielding devices. Additionally, we will create a multi-target stimulation control system that integrates feedback interfaces for coil temperature, magnetic field intensity, current intensity, voltage intensity, and noise acquisition. Using multimodal clinical data, we will develop intelligent algorithms for array coil control based on the synergy between target location and stimulation intensity. We will validate the effectiveness and safety of the smart magnetic helmet in rehabilitating the neurofunction and motor impairments of stroke patients.
Contact: Associate Professor Alan Wang (alan.wang@auckland.ac.nz)
Keywords: transcranial magnetic stimulation; stroke rehabilitation; brain function; neuroplasticity

Project: Novel approach for Her2×Her3 bispecific antibody-drug conjugate targeting breast cancer
Bispecific antibody–drug conjugates (bsADC) is a targeted anti-tumour drug with coupling cytotoxic drug and bispecific antibody. It is predicted that bsADC will play an important role in the development of targeted therapeutics against cancer in the coming years.
A novel approach for bispecific antibody-drug conjugate will be developed in this project. Bispecific antibody with natural antibody structure or five amino acids left in the hinge region can be produced in our collaborative research facility. We will use the advantages of the "BAPTS"(Bispecific Antibody by Protein Trans-Splicing) technology platform to design sites for conjugation in the hinge region to conjugate the bispecific antibody and cytotoxic drugs. Site-specific conjugation will be applied for bsADCs design. BsADCs with high homogeneity will be produced by this study. This novel synthesis method of bispecific antibody–drug conjugates will provide promising biopharmaceutics for future clinical drug discovery and development. We will design Her2×Her3 bsADC targeting breast cancer, in particular those with multi-drug resistance. This research will also provide reliable theoretical and technical support for the further research of bispecific antibody–drug conjugates.
Contact: Professor Jun Lu (jun.lu@auckland.ac.nz)
Keywords: breast cancer; antibody drug; drug synthesis; biopharmaceuticals

Project: Spermine/spermidine acetyltransferase as therapeutic target for diastolic heart failure in streptozotocin-induced diabetic rat model

Diabetic heart failure develops in most diabetic patients, independent of ischemic heart disease and hypertension. Currently, this condition is the most common (>50%) type of heart failure worldwide including in New Zealand. Metabolic alterations in diabetes are closely associated with diabetic heart failure. Polyamine metabolism may influence such metabolic changes. As polyamine metabolism has previously been shown to have implications in various complications of diabetes mellitus, we propose that the induction of the rate limiting enzyme of polyamine metabolism (Spermine/Spermidine Acetyltransferase - SSAT) may provide a unique, novel treatment approach for diabetic heart failure. It is also important to find an effective treatment for diabetes-related heart failure because the underlying mechanism for this condition is entirely different from non-diabetic heart failure, thus the routine treatment of heart failure could be ineffective. We plan to study the therapeutic effect of three SSAT inducers in a diabetic rat model, which have previously shown to be a good experimental model of diabetes-related heart failure.

Contact: Professor Jun Lu (jun.lu@auckland.ac.nz)

Keywords: diabetic heart failure; polyamine metabolism; spermine; spermidine

Project: Anticancer properties and mechanisms of fucoidan on breast cancer

The incidence of breast cancer has been rising for the past few decades. Targeted therapeutics have improved the life expectancy of patients, however their success is undermined by the appearance of resistance in most patients. Aggressive tumours rewire alternative pathways such as NRAS, c-RAF, AKT, PDGFRβ, IGF1 and ERBB3. Hence, therapies combining multiple inhibitors such as BRAF and MEK inhibitors to delay the onset of recurrence have now entered clinical trials. These novel treatments have extended patient survival, yet they are far from halting breast cancer.

Over 70% of anti-cancer agents have their origin in natural sources. Fucoidan is a mixture of highly sulphated polysaccharides of brown algae with anti-tumour, anti-inflammatory, anticoagulant, anti-angiogenic activities. Extracts from the New Zealand U. pinnatifida are more effective than pure fucoidan at inhibiting cancer cell growth. Recent studies have shown fucoidan and its low molecular fraction can synergise with standard anti-cancer agents and/or can reduce their toxicity. Studies show that lapatinib inhibits ERBB3 signalling and hampers the survival and tumorigenesis of breast carcinoma, supporting a key role of ERBB3/2 in the pathogenesis of the disease and providing the rationale for targeting this signalling cascade. However, lapatinib alone, at therapeutically safe doses, can only delay breast cancer growth, not halt it.

We therefore hypothesise that fucoidan can safely potentiate the therapeutic properties of lapatinib by enhancing its inhibitory effects on major survival pathways in breast cancer.

Contact: Professor Jun Lu (jun.lu@auckland.ac.nz)

Keywords: breast cancer; fucoidan; lapatinib; cancer treatment

Project: An instrument for high throughput, multi-day, functional assessment of mechanically loaded cardiac muscles

Many muscles can be dissected from a heart, but no more than one can be studied at a time in a day. This project will devise an entirely new instrument which can study many muscles at a time, and for over a week. In this project, you will construct a device to host many muscles and see how each muscle uniquely responds to mechanical stimuli, rate of pacing, and drugs. You will culture each muscle, provide them with nutrients and

see how they grow in the device over a week – they will look different every day and you will image them using light microscopy. You will have the opportunity to enhance your bioinstrumentation and cardiac experimentation skills, by working with bioengineers and cardiac physiologists.
This project will aim to: (i) develop an experimental device and software controller to maintain heart muscles in long-term cultivation; (ii) perform functional experiments on cultured muscles under various mechanical and pharmacological interventions; (iii) perform structural experiments using transmission electron microscopy imaging to assess ultrastructural remodelling.
Contact: Dr Toan Pham (toan.pham@auckland.ac.nz)
Keywords: bioinstrumentation; cardiac function; high throughput device; hardware development

Project: Heart rate variability: experiment and modelling
Take a moment to listen to your heart beat. It probably feels like it is ticking along at a constant rate. But that's not the case. Your heart rate instead varies largely in sync with your breathing. This is called "heart rate variability" (HRV). This project aims to uncover the physiological significance of HRV by answering two major questions: What physiological benefits does HRV confer on the heart? Without HRV, what makes the heart fail?
This study is timely given frequent monitoring of HRV using smartphones to assess overall well-being (healthy heart, physical fitness, healthy ageing). This study is also topical given recent concerns about the disappearance of HRV under conditions of cardiovascular complication and sudden cardiac death.
Project Objectives: 1) Perform experiments on heart muscles using our world's only devices. Measurements include energy liberation of the muscles, and cellular Ca2+ handling within the muscles; 2) Extend our mathematical models of cardiac muscle biophysics and use the models to interpret the functional data obtained in Objective 1; 3) Use the models to make some predictions which can be tested experimentally.
Contact: Dr June-Chiew Han (j.han@auckland.ac.nz)
Keywords: heart rate variability; computational modelling; muscle experimentation; heart disease

Project: Improving mitochondrial function to rescue type 2 diabetic heart failure
New Zealand currently faces a diabetic epidemic, with heart failure remaining the leading cause of premature death. In patients with Type 2 diabetes, their hearts progressively and abnormally enlarge and thus require an increased energy supply. We propose that the diabetic heart suffers an impairment, and insufficiency, of energy supply by the cell's 'powerhouse' (mitochondria). This leads to the weakened pumping ability of the heart muscle to eject blood. This project aims to investigate the link between mitochondrial function and overall pumping performance. It will use a novel drug to test whether improving mitochondrial function can recover the pumping ability of the diabetic heart. The project will involve bioinstrumentation and experiments using a suite of novel techniques to measure the energy inputs, outputs and efficiencies of the heart at tissue and sub-cellular levels. This project will uncover the underlying mechanisms and the therapeutic potential of targeting the energy supply chain of the diabetic heart.
Contact: Dr Toan Pham (toan.pham@auckland.ac.nz)
Keywords: diabetic heart failure; mitochondria; energy supply; bioengineering

Project: Architecture and electrical function of the human right-side heart outflow region

There is a growing interest to understand more about the right side of the heart when it is healthy and when it is diseased. In many cases, the origins of potentially fatal disturbances in normal electrical heart rhythms are linked to the right-side outflow region. Detailed 3D images of human heart tissue around the region show varying and complex arrangements of cells and connections that could impact the progression of electrical signals. However, there are many aspects of interactions between the architecture of cell groups and electrical function that we do not understand. Computer models are indispensable tools to help with this. The aims of the project are to develop and refine (1) models that describe cell and tissue architectures and communication pathways in the outflow region using custom filters, deep-learning methods, and graphs, and (2) models that predict biophysically how these features contribute to normal and dangerous electrical sequences.

This is a unique opportunity to be part of a program that applies computational engineering and science to make sense of advanced imaging data. This project will be ideal for students with well-developed skills in computer modelling, algorithm design, image analysis and signal and data processing. The applicant will need to have an interest in biophysics or related topics and be confident with mathematics, algorithm specification and computer programming. They will want to be a good planner, able to manage complex data, open to mentoring and motivated to write reports and papers.

Contact: Dr Mark Trew (m.trew@auckland.ac.nz)
Keywords: computational modelling; deep learning; right ventricle; heart disease; electrophysiology

Project: AI-driven musculoskeletal image-based modelling

The musculoskeletal system is fascinating and mechanically complex. The state of the art in generating novel insights into musculoskeletal form and function comes from computational models that can resolve the system's complexity. The cutting edge of computational modelling is based on medical image data, where in vivo anatomical data informs mechanical models. In this advanced bioengineering, computational modelling, and medical image processing project, a high achieving student will work with cutting edge deep learning tools to build and train networks that will rapidly generate biomechanics models from novel data.

The student will be supervised by two research groups at the ABI - the Musculoskeletal Modelling Group and the Animus Laboratory. Students interested in biomechanics, musculoskeletal modelling, and image processing will find this a rewarding and challenging project at the intersection of Artificial Intelligence, musculoskeletal bioengineering, computational modelling, and biomechanics.

Contact: Dr Geoff Handsfield (g.handsfield@auckland.ac.nz)
Keywords: musculoskeletal modelling; biomechanics; artificial intelligence

Associate Professor Alys Clark (alys.clark@auckland.ac.nz)

We are looking for students with an interest in computational modelling, with a focus on pregnancy health and the development of the foetus. We have projects that will look at how the development of the placenta influences the foetal heart, which will be used to guide ultrasound assessment of pregnancy. We are also interested in hearing from students who are interested in computational modelling alongside physiological studies,

as typically promising treatments for pregnancy complications in animal studies do not readily translate to human pregnancy. We have opportunities available to help to resolve these issues via combined computational and experimental approaches.
Keywords: bioengineering; computational modelling; medical imaging

Dr Bryan Ruddy (b.ruddy@auckland.ac.nz)
Many medical devices, such as prosthetics, exoskeletons, and drug delivery systems, are limited by the efficiency and capability of the actuators that drive them. Further, the actuator behaviours needed for medical device applications can be very different from those traditionally used in industrial applications - medical device actuators need to be specifically designed for the task at hand to achieve the desired performance. My team and I work to design linear electric motors, voice coils and linear synchronous motors, specifically for high-performance medical devices. Linear synchronous motors are flexible, powerful, and efficient actuators that have seen little use to date in biomedical applications. We are open to accepting students with scholarships to join our team and work on the application of these actuators to tasks such as drug delivery and rehabilitation robotics, developing motor designs optimised to each task along with their compact, self-contained motor controllers. The goal of such a project would be to use the optimisation methods previously developed by the investigators to create plug-and-play actuator systems for these new applications and to examine the performance of these systems, as well as the overall medical device performance enabled by the new motors.
We are also interested in taking on students who are interested in exploring the clinical application of rehabilitation robots and human joint characterization systems. The goal of a project in this category would be to work with clinicians and patients to develop a therapeutic approach using one of the medical devices we have previously developed and to validate this approach with participants who would benefit from the therapy.
Keywords: medical devices; electrical machines and drives; rehabilitation robotics

Dr Kenneth Tran (k.tran@auckland.ac.nz)
I am searching for students with an interest in computational modelling in the areas of cardiac physiology and energy metabolism. I have projects that look to investigate how cardiac mechanics and energetics is perturbed in disease, particularly in diabetic cardiomyopathy. This work involves collaborations with local and international experts in the fields of cardiac and mitochondrial physiology and mathematical modelling. Experimental data gathered from animal models and consenting patients from Auckland Hospital will be used to develop novel models of cardiac cellular bioenergetics using a bond graph framework to ensure thermodynamic consistency. The models will be used to simulate potential therapeutic treatments that can improve cardiac function. I am looking for students to take on this challenge and make a difference in the lives of people with heart disease.
Keywords: heart disease; computational modelling; bioengineering; cardiac metabolism

The projects listed in this booklet are just a few of the many possible research projects suitable for doctoral study in the Faculty of Arts at the University of Auckland. For information about other areas of active research in which it might be possible to undertake doctoral studies, see the following webpages:

PhD in the Faculty of Arts

- **Doctoral study in Ancient History**
- **Doctoral study in Anthropology**
- **Doctoral study in Applied Linguistics**
- **Doctoral study in Art History**
- **Doctoral study in Asian Languages and Cultures**
- **Doctoral study in Comparative Literature**
- **Doctoral study in Criminology**
- **Doctoral study in Development Studies**
- **Doctoral study in English**
- **Doctoral study in European Languages and Culture**
- **Doctoral study in Gender Studies**
- **Doctoral study in Greek**
- **Doctoral study in History**
- **Doctoral study in Latin**
- **Doctoral study in Latin American Studies**
- **Doctoral study in Linguistics**

- **Doctoral study in Māori Studies**
- **Doctoral study in Media and Screen Studies**
- **Doctoral study in Pacific Studies**
- **Doctoral study in Philosophy**
- **Doctoral study in Politics and International Relations**
- **Doctoral study in Sociology**
- **Doctoral study in Theology**

Dr Jesse Hession Grayman (j.grayman@auckland.ac.nz)
I am a Senior Lecturer in the Development Studies programme in the School of Social Sciences. My PhD is in Medical Anthropology, and I have an MA in Southeast Asian Studies, with a focus on Indonesian language, literature, and history. I do most of my research in Indonesia, and I have supervised several Indonesian students over the years, including MA and PhD students, and including students with the LPDP award. I am fluent in Bahasa Indonesia. I lived in Indonesia for more than 15 years of my adult life, in Jakarta, Yogyakarta, West Kalimantan, and especially in Aceh, with lots of fieldwork completed elsewhere such as Gorontalo, Madura, West Java, and Flores. I am looking to work with students interested in the areas listed below.
Keywords: humanitarian interventions; disasters and disaster recovery processes; global health; post-conflict recovery; medical anthropology; development studies; Indonesian literature; mental health; community driven development; rural development; village development; tourism

Dr Nicholas Malone (n.malone@auckland.ac.nz)
Projects:
1) Forest histories and population futures: the human / gibbon interface in West Java
2) Human-macaque interactions in Bali. Using the theory and methods of 'ethnoprimatology', these projects aim to identify factors shaping the behaviour and ecology of the interactants.
Keywords: ethnoprimatology; primate conservation

Dr Sereana Naepi (s.naepi@auckland.ac.nz)
I am interested in supervising decolonial projects in relation to West Papua and Indonesia's ongoing colonial exploitation of a Pacific nation. Despite ongoing international pressure for UN access to West Papua to ensure that reports of genocide are unfounded, Indonesia refuses to allow access and continues to profit extensively through stolen land, resources and systemic genocide of Indigenous Papuans. West Papua contributes extensively to the Indonesian government budget which is then used to provide things such as higher education that Papuans are unable to access equitably. I am interested in exploring and recording these stories of colonial genocide and how Indonesia's higher education system benefits from this.
Keywords: higher education; colonisation; genocide; West Papua; decolonisation

Associate Professor Jamie Gillen (jamie.gillen@auckland.ac.nz)
Keywords: tourism; Southeast Asia; urbanization; agrarian transformation

Dr Hee-seung Irene Lee (irene.lee@auckland.ac.nz)
Keywords: contemporary Korean films and TV series; East Asian popular culture; art-house cinema; film adaptation of literature; critical theory

Dr Bridget Conor (bridget.conor@auckland.ac.nz)
Keywords: media and screen production industries; feminist media studies; cultural/communication employment

Dr Changzoo Song (ch.song@auckland.ac.nz)
Keywords: Asian diasporas; diasporic identities; migrations in Asia; ethnic nationalism and multiculturalism in Korea; foreign workers in South Korea

Dr Danping Wang (danping.wang@auckland.ac.nz)
Keywords: Chinese language education; translanguaging; decolonising language teaching; multimodality; language teacher identity; language policy

Dr Norbert Vanek (norbert.vanek@auckland.ac.nz)
Keywords: bilingualism and thought; cross-linguistic influence in second language acquisition; event cognition; linguistic relativity; reference to time/space/person/negation in L2; linguistic modulations in olfactory/gustatory/tactile/visual category formation

Dr Trudy Agar (t.agar@auckland.ac.nz)
Keywords: Francophone literature; translational literature; bilingualism in literature; literary trauma studies

Associate Professor Louisa Buckingham (l.buckingham@auckland.ac.nz)
(I can consider applications from July 2024)
Keywords: applied sociolinguistics; multilingual societies and institutions; migration; language and economics; heritage language maintenance; language issues related to religion; ageing; the workplace; public spaces

Associate Professor Tan Bee Tin (tb.tin@auckland.ac.nz)
(I can consider applications from mid-2025)
Keywords: creativity in language teaching/learning; the role of interest in language teaching/learning; materials development and evaluation; language teaching in Asian contexts

UNIVERSITY OF AUCKLAND
Waipapa Taumata Rau
NEW ZEALAND

BUSINESS SCHOOL

The projects listed in this booklet are just a few of the many possible research projects suitable for doctoral study in the Faculty of Business and Economics at the University of Auckland. For information about other areas of active research in which it might be possible to undertake doctoral studies, see the following webpages:

Doctoral study in Business

- **Doctoral study in Accounting**
- **Doctoral study in Commercial Law**
- **Doctoral study in Economics**
- **Doctoral study in Finance**
- **Doctoral study in Information Systems**
- **Doctoral study in International Business**
- **Doctoral study in Management**
- **Doctoral study in Marketing**
- **Doctoral study in Operations and Supply Chain Management**
- **Doctoral study in Property**

Project: Influence on culture on hospitality traditions and food waste
There is an available position for a doctoral researcher to use qualitative research to examine how culture and/or religion influences the trade-off between being hospitable to visitors and reducing food waste.
Contact:
Associate Professor Karen V. Fernandez (k.fernandez@auckland.ac.nz)
Dr Sandra D. Smith (sd.smith@auckland.ac.nz)
Keywords: qualitative research; food waste; sustainability; hospitality

Project: Immersive technologies in services marketing: a new frontier
The project "Immersive Technologies in Services Marketing: A New Frontier" aims to investigate and analyse the impact of immersive technologies on services marketing. By employing virtual and augmented reality, this research explores innovative ways services can be marketed to consumers. The project involves both quantitative and qualitative research methodologies and offers PhD students a platform to investigate novel concepts, while also collaborating with industry stakeholders.
Contact: Dr. Shahper Richter (shahper.richter@auckland.ac.nz)
Keywords: immersive technologies; services marketing; virtual reality; augmented reality; innovation; digital marketing

Associate Professor Laszlo Sajtos (l.sajtos@auckland.ac.nz)
Research focussing on technology-infused customer-employee interactions.
Keywords: customer-robot interactions; intelligent automation; self-quantification; generative AI

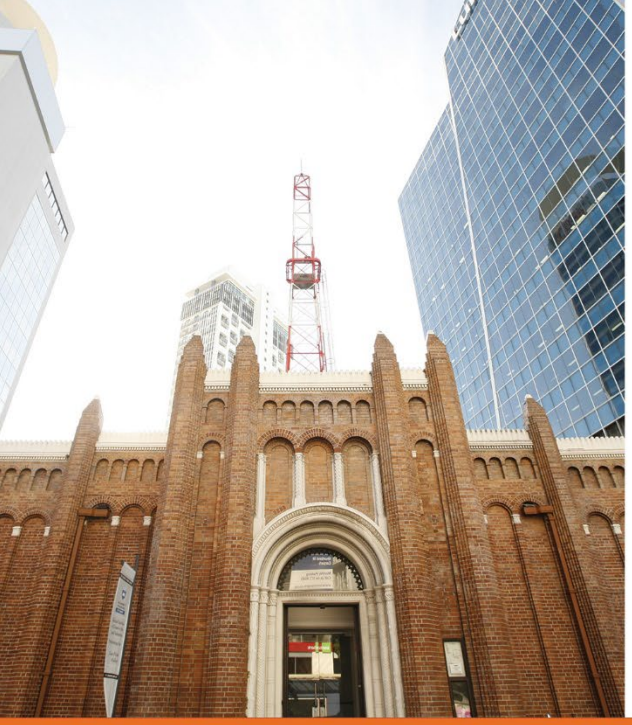
Dr. Shahper Richter (shahper.richter@auckland.ac.nz)
I am currently leading a research project exploring the intersection of immersive technologies and services marketing. I am looking for highly motivated PhD students to join this innovative venture. The project offers an in-depth analysis of how immersive technologies such as virtual and augmented reality can revolutionize how services are marketed. As a part of the team, you will have the opportunity to work on cutting-edge research, collaborate with industry experts, and contribute to shaping the future of marketing.
Keywords: immersive technologies; virtual reality; augmented reality; services marketing; digital marketing

Dr Angela Liew (a.liew@auckland.ac.nz)
Areas of supervision available (from late 2024):

- The Future of Accounting Work: The Human Impacts of Automation & Artificial Intelligence
- Industry 4.0 and Digitalization: The Effects of Information Technology (Accounting Information Systems)
- Digital Transformation in the accounting sectors and commercial businesses
- Digital Competencies and Building a Sustainable Workforce
- The Interactions between humans and machines
- Interview-based Research and Field-Research in Accounting
- Management Controls
- Forensic Accounting and Fraud Auditing
- New Product Development (NPD)
- Airline industry, aviation industry
- Aquaculture industry (the breeding, raising, and harvesting of finfish, shellfish, and aquatic plants)

Keywords: management accounting: accounting, auditing and accountability; business information systems; white collar crime; aquaculture

Dr Johnny Chan (jh.chan@auckland.ac.nz)
My research interest is the application and impact of emerging technologies, like artificial intelligence (AI) and blockchain, on individuals, organisations, and societies. My recent projects have focused on the application of machine learning, natural language processing and generative AI, and how we could apply them responsibly.
Keywords: artificial intelligence; machine learning; deep learning; natural language processing; generative AI; blockchain; decentralised network; decentralised identity; web5



UNIVERSITY OF AUCKLAND
Waipapa Taumata Rau
NEW ZEALAND

CREATIVE ARTS AND INDUSTRIES

The projects listed in this booklet are just a few of the many possible research projects suitable for doctoral study in the Faculty of Creative Arts and Industries at the University of Auckland. For information about other areas of active research in which it might be possible to undertake doctoral studies, see the following webpages:

Introduction to doctoral study at Creative Arts and Industries

- **Doctoral study in the School of Architecture and Planning**
- **Doctoral study in the Dance Studies Programme**
- **Doctoral study in Fine Arts and Design**
- **Doctoral study in the School of Music**

Associate Professor Julia Gatley (julia.gatley@auckland.ac.nz)
I am interested in supervising a broad range of PhD topics in architectural history and architectural heritage conservation. While most of my own writing is on New Zealand architecture, I have taught a course on the history of Asian architecture, have broad interests in this field, and am currently supervising doctoral students working on topics in India and Myanmar. Both are taking a typological approach, with one focusing on forts and the other on palaces.
Keywords: history of architecture; history and theory of architectural heritage conservation

Dr. Diana Albarran Gonzalez (d.albarran@auckland.ac.nz)
My research interests are centred on decolonial views on design-craft-art, particularly artisanal textiles, through context-based and culturally-appropriate approaches.
These views are based on collaborative research (co-design, participatory design), foster plurality (pluriversal design, indigenous design, DEI), are ethical (equity-centred, values-driven), and seek to support the collective well-being of different communities in relation to their nature-culture contexts.

Keywords: design; design anthropology; indigenous methodologies; social innovation; crafts and artisanal textiles; collective wellbeing

Dr Lucille Holmes (la.holmes@auckland.ac.nz)
I am a senior lecturer in Fine Arts with expertise in interrelations between Lacanian psychoanalysis and artistic practices. I also have research interests in cultural and critical theory, continental philosophy, postcolonial theory, sexual difference, and feminism. I am an experienced doctoral supervisor has and have supervised PhDs in a wide range of artistic media including painting, installation, performance, and electronics and in topics related to psychoanalysis, Western and Eastern philosophy, and cultural theory.
Keywords: cultural and critical theory; continental philosophy; postcolonial theory; sexual difference and feminism

Dr. Fabio Morreale (f.morreale@auckland.ac.nz).
In my research, I explore the intersection of Artificial Intelligence (AI) and the creative arts both from artistic and political perspectives. First, I aim to surface the underlying ethical and political issues associated with using artists' work in training AI datasets, uncovering potential exploitative practices. Second, I seek to employ non-Western decolonial approaches, epistemologies, and knowledge systems in developing AI systems. Third, I aim to develop accessible techniques that democratise AI tools for artists who may lack technical knowledge but are interested in exploring this medium.
Keywords: artificial intelligence; labour exploitation; generative AI

Dr Lee Beattie (l.beattie@auckland.ac.nz)
I am interested in supervising a range of PhD topics in urban design, surrounding issues relating to the design approach to 15 minute cities, transit oriented development and the design guidance to improving the quality of built form on my PhD lab.
Keywords: urban design theory and practice

Dr. Allan Fowler (allan.fowler@auckland.ac.nz)
I have capacity for a doctoral candidate to work on a game development project (game developer/programmer). This project aims to research and design a game to inform and educate users about reciprocal care between themselves and the forest. This game will help the player learn the interdependency between humans and ecosystems. Through this game, the user will learn through play and help reinforce the importance of the interdependency between themselves and the forest. The candidate will be involved in developing the game using the Unity game engine. Familiarity with the Unity game engine and C# are core requirements for this project. We plan to develop and publish the game on Steam and Google Play.
Keywords: game design; games for learning; augment & virtual reality; human-computer interaction; understanding neurodiversity

UNIVERSITY OF AUCKLAND
Waipapa Taumata Rau
NEW ZEALAND

EDUCATION AND SOCIAL WORK

The projects listed in this booklet are just a few of the many possible research projects suitable for doctoral study in the Faculty of Education and Social Work at the University of Auckland. For information about other areas of active research in which it might be possible to undertake doctoral studies, see the following webpages:

Doctoral study in Education

Research centres:

- **Woolf Fisher Research Centre**
- **Te Puna Wānanga School of Māori and Indigenous Education**
- **Centre for Learning and Research in Higher Education**
- **The Marie Clay Research Centre**
- **Centre for Community Research and Evaluation**
- **Centre for Child and Family Research**
- **Critical Research Unit in Applied Theatre**
- **Knowledge and Education Research Unit**
- **Parenting Research Group**
- **The Richard Tinning Research Unit**
- **Higher Education Research Network**
- **Quant-DARE - Quantitative Data Analysis and Research**

Project: Early Childhood Education and Childhood Studies
I am seeking candidates interested in PhD studies in early childhood education (birth to 8) or childhood studies (birth to 18) within the transdisciplinary framework of the Centre for Global Childhoods. Particularly of interest are projects that relate to contemporary global issues of children and childhoods, and that are considering utilising posthuman and new materialist methodologies, but other theoretical and philosophical, qualitative or mixed-methods studies are also accepted.
Contact: Professor Marek Tesar (m.tesar@auckland.ac.nz)
Centre for Global Childhoods
Keywords: early childhood; early years; childhood studies

Project: Advancing equity and social justice in education
I welcome PhD candidates interested in examining topics of equity and justice in education. I particularly encourage inquiries that critically analyse the challenges faced by historically underserved and marginalised communities in both urban and rural settings in the primary and secondary sectors, as well as in teacher education.
Contact: Dr Jennifer Tatebe (j.tatebe@auckland.ac.nz)
Keywords: equity; justice; urban; rural; teacher education

Project: Community-based research
I welcome PhD candidates interested in the creative utilisation of community-based sites and practice-based research strategies to enable research that makes a difference in practice. I particularly encourage inquiries that consider atypical alliances in the development of credible evidence across the health and social services sector.
Contact: Professor Christa Fouché (c.fouche@auckland.ac.nz)
Keywords: practice-based research; social services; community

Project: Professional supervision
I am interested in supervising research on professional supervision across a range of helping professions. The research may include sustainability and development of interprofessional supervision, critical reflection in supervision, workplace wellbeing and the effectiveness of professional supervision within different organisations. You will have a passion for exploring practice in different contexts, qualitative research, and participatory action research methods. My professional experience is in social work and community practice and spans over 25 years.
Contact: Dr Matt Rankine (m.rankine@auckland.ac.nz)
Keywords: supervision; development; interprofessional; workplace

Project: Development of the profession of social work
I am interested in supervising students who wish to explore the development of the social work profession, including social work education, professional identity, professional development, and supervision. While social work is an internationally recognised profession, it is in different stages of development in different geographical, political, and cultural contexts and cross-border collaborative investigations are of great value.
Contact: Professor Liz Beddoe (e.beddoe@auckland.ac.nz)
Keywords: social work; professional identity; continuing professional development in social work

UNIVERSITY OF AUCKLAND
Waipapa Taumata Rau
NEW ZEALAND

ENGINEERING

The projects listed in this booklet are just a few of the many possible research projects suitable for doctoral study in the Faculty of Engineering at the University of Auckland. For information about other areas of active research in which it might be possible to undertake doctoral studies, see the following webpages:

Doctoral study in Engineering

- **Doctoral study in Chemical and Materials Engineering**
- **Doctoral study in Civil Engineering**
- **Doctoral study in Electrical and Electronic Engineering**
- **Doctoral study in Computer Systems Engineering**
- **Doctoral study in Software Engineering**
- **Doctoral study in Engineering Science**
- **Doctoral study in Mechanical Engineering**
- **Doctoral study in Mechatronics Engineering**

- ***Department of Engineering Sciences and Biomedical Engineering***

Projects: We are part of the Geothermal Modelling Group located within the Department of Engineering Science and affiliated with the Geothermal Institute at the University of Auckland. We carry out cutting-edge research on computational modelling of geothermal fields. The methods and software we develop are used by engineers and scientists around the world. As well as consulting on commercial projects, we host international students and supervise PhD and Masters research projects. Our current research interests include:

- Geothermal modelling innovation
- Inverse modelling (automatic calibration)

- Uncertainty quantification of geothermal models
- Modelling of geothermal systems down to their base at the brittle-ductile zone
- Geothermal resource assessment
- Coupling reservoir, wellbore and surface equipment models to create a digital twin of a geothermal project
- Geothermal modelling for Net Zero Carbon 2050 energy transition

Contacts:
Dr John O'Sullivan (jp.osullivan@auckland.ac.nz)
Dr Michael Gravatt (michael.gravatt@auckland.ac.nz)
Dr Theo Renaud (theo.renaud@auckland.ac.nz)
Dr Ru Nicholson (ruanui.nicholson@auckland.ac.nz)s
Dr Oliver MacLaren (oliver.maclaren@auckland.ac.nz)
Professor Michael O'Sullivan (m.osullivan@auckland.ac.nz)
Keywords: geothermal modelling; inverse modelling; uncertainty quantification; geothermal resource assessment; digital twins, zero carbon

Associate Professor Mike O'Sullivan (michael.osullivan@auckland.ac.nz)
Projects: Currently I have multiple projects on the use of digital twins: 1) for creating virtual reality experiences that enable communities to participate in evidence-based, model-informed decision making in areas such as infrastructure, the environment, etc; 2) for understanding, evaluating and improving healthcare service delivery. See https://orua.auckland.ac.nz/case-studies/ for examples of my research work.
Keywords: optimisation; simulation; analytics; mathematical modelling; digital twins

- ***Department of Civil and Environmental Engineering***

Project: Properties of treated and untreated expansive soils
Expansive soils occur in many parts of the world including New Zealand. They exhibit swell-shrink behaviour when exposed to wetting and drying conditions. This volume instability causes millions of dollars' worth of damage to infrastructure. The common practice to treat expansive soils is to add binding materials such as lime and cement. Effectiveness of these treatment materials are site-dependent and not well understood. Other solutions, including pre-treatment, curing condition, fibre addition and alkali-activated binders to stabilize these soils, are reported in the literature. The objective of this study is to investigate the behaviour of expansive soils in Auckland, New Zealand when they are treated with various solutions including pre-treatment, fibre addition and alkali activation. The results will be compared with the behaviour of the original untreated expansive soils. The shrink-swell behaviour, unconfined compressive strength, tensile strength and triaxial testing are among the tests to be conducted. The aim of this study is to develop a solution that is least sensitive to the expansive soil type in New Zealand, has low CO2 emissions, and is economical.
Contact: Dr Arezoo Rahimi (arezoo.rahimi@auckland.ac.nz)
Keywords: ground improvement; expansive soil treatment

Project: Develop a water harvesting framework for solar farms
Solar farms are large-scale solar installations where photovoltaic (PV) panels are aligned and connected together to harvest solar energy and convert it to electricity. The useful applications of solar farms in the energy sector have been extensively studied. There

are, however, other benefits that these farms provide. Solar panels are clean and impervious surfaces that produce a total impervious dynamic catchment when arranged into a solar farm setting. The solar panels are tilted and rotated to get maximum sunlight. This ability to change can be an advantage – panels can collect maximum runoff and harvest water during a storm event. The increase in solar farms in rural communities provides the impetus to investigate their water harvesting benefits. This project investigates potential water harvesting techniques to be used in solar farms that can benefit rural communities.
Contact: Dr Kilisimasi Latu (kilisimasi.latu@auckland.ac.nz)
Keywords: water harvesting; solar farms; hydrologic response

Project: Physics-based simulation of rolling contents during earthquakes
The dynamic response of building contents during earthquakes poses a significant challenge for earthquake engineers. Sliding, rocking, and toppling of contents can lead to injuries and disrupt critical infrastructure operations. This project will examine the fundamental science underlying the seismic performance of equipment on castors, which often form essential parts of critical machinery, telecommunication systems, and hospital equipment. . Through a combination of physical experiments and comprehensive desktop studies, the project will investigate the influence of various factors on equipment behaviour, including the number of castors, castor size, arrangement, material, and angle. Additionally, the friction and stiffness properties of the flooring material, the location of equipment within a building, the weight, aspect ratio, and configuration of the equipment, as well as the characteristics of earthquake input, will be thoroughly examined. By uncovering novel insights into the behaviour of equipment on castors during seismic events, this project aims to contribute to the development of improved modelling techniques and enhance the safety of critical infrastructure, ultimately mitigating the risks and consequences associated with earthquake-induced damage.
Contact: Dr Quincy Ma (q.ma@auckland.ac.nz)
Keywords: earthquake engineering

Project: Use of computer vision for earthquake engineering research and structural health monitoring
This project explores the use of consumer-grade cameras and state-of-the-art computer vision techniques in earthquake engineering laboratory experiments and automated structural health monitoring. The project expects to leverage recent advances in image processing and computation power and apply novel approaches, such as phase amplification of motion, automatic target recognition, and image stabilization, as a new measurement technique. The project will lead to cost-effective monitoring solutions that will overcome shortcomings of traditional approaches, resulting in more reliable and informed structural-damage detection and building decisions following earthquakes. The project will also examine the use of AI, machine learning, and pattern recognition to develop an automated self-improving solution.
Contact: Dr Quincy Ma (q.ma@auckland.ac.nz)
Keywords: earthquake engineering

Project: Advances in accounting for aeroelastic effects in wind tunnel tests of scaled building models
This project aims to explore a novel approach in quantifying the significance of unintended aeroelastic effects in wind tunnel tests of slender building models. Through a combination of experimental and analytical approaches, the project aims to improve the

reliability of high-frequency force balance (HFFB) and high-frequency pressure integration (HFPI) methods. The findings will contribute to the improvement of wind tunnel testing practices and streamline future design process for structures under wind loading.
Contact: Dr Quincy Ma (q.ma@auckland.ac.nz)
Keywords: wind engineering

Project: Post-installed anchors in concrete
Post-installed anchors in concrete are used for a multitude of reasons. Although the conceptualisation of a post-installed anchor is straightforward, the number of variables to be considered is extensive. Anchors can be used in seismic and non-seismic applications, can be placed in cracked or uncracked concrete, can have limited edge distances, may be temporary or permanent, can be threaded, sleeved, or adhesive-fixed, and may support either primary or secondary load paths, to name just some of the issues to be considered. This doctoral thesis topic will investigate the various fundamental applications of post-installed anchors, the existing international design recommendations, experimental gaps in knowledge, and make recommendations on suitable future design criteria.
Contact: Professor Jason Ingham (j.ingham@auckland.ac.nz)
Keywords: concrete; earthquake engineering

Project: Seismic response of torsionally-responding unreinforced masonry buildings
New Zealand unreinforced masonry (URM) buildings are typically solid or near-solid on 3 sides, but heavily penetrated on the street frontage. For in-plane response, it follows that most URM buildings are seismically vulnerable because there is inadequate in-plane capacity of the front facade. However, empirical evidence indicates that these building respond better in earthquakes than is forecast from assessment methods. The reason for this favourable response is possibly due to torsional response, and yet the seismic torsional behaviour of unreinforced masonry buildings has received little research attention. The purpose of this thesis is to use scale models and numerical modelling to investigate the seismic torsional response of unreinforced masonry buildings.
Contact: Professor Jason Ingham (j.ingham@auckland.ac.nz)
Keywords: unreinforced masonry; earthquake engineering; numerical modelling

Project: FRP anchors for seismic applications
Fibre reinforced polymers (FRP) are not new, and their application in seismic strengthening has been investigated for several decades. However, one issue that continues to be challenging is how to adequately anchor the fibres in order to develop full capacity. This thesis will investigate a new method for anchoring, involving steel plates in conjunction with FRP anchors.
Contact: Professor Jason Ingham (j.ingham@auckland.ac.nz)
Keywords: earthquake engineering

Project: Seismic response of concrete dams in New Zealand
Concrete dams were first built in New Zealand in about 1906, which was approximately three decades before the first seismic design code in the country. These structures are now heritage, and as our collective understanding of seismic hazard increases the calculated seismic capacity of these structures become increasingly inadequate. Dams store water, and the provision of water after an earthquake is imperative to the ongoing

wellbeing of a community. However, the seismic capacity of New Zealand's concrete dams has received minimal research attention. The purpose of this thesis is to develop a suitable understanding of the seismic capacity of the existing stock of concrete dams in New Zealand.
Contact: Professor Jason Ingham (j.ingham@auckland.ac.nz)
Keywords: earthquake engineering; concrete

Project: Understanding the impact of vertical excitation on the seismic response of unreinforced masonry buildings
In the Canterbury earthquake sequence the level of vertical acceleration exceeded 1g in some locations. For an unreinforced masonry building this excitation implies that at various points in time the building lost any compression associated with normal gravity loads, which is the only mechanism keeping the building standing. So far, the issue of vertical acceleration has been ignored in seismic assessment methodologies. This study will seek to understand how seismic excitations should be accounted for. It is anticipated that the study will involve implementation of discrete element analysis and possible small-scale shake table testing.
Contact: Professor Jason Ingham (j.ingham@auckland.ac.nz)
Keywords: earthquake engineering; concrete

Project: Integrating virtual reality gaming technology and detailed numerical modelling of unreinforced masonry building
Discrete Element Analysis is an advanced numerical modelling strategy for unreinforced masonry (URM) buildings. Physics engines are used in the development of virtual reality simulations. This study will seek to explore how to integrate the two technologies such that accurate and meaningful simulations of entire precincts of URM buildings can be undertaken. The study will involve multiple digital technologies including the acquisition of building information using drones and LIDAR, and then simulate seismic excitation.
Contact: Professor Jason Ingham (j.ingham@auckland.ac.nz)
Keywords: earthquake engineering; numerical modelling; digital technology

Professor Rolando P Orense (r.orense@auckland.ac.nz)
My research group has been investigating various aspects of soil liquefaction, from the nature of the hazard to its assessment and mitigation. Our approach includes conducting post-earthquake ground investigations, understanding the dynamic behaviour of geomaterials through laboratory and field testing, performing numerical analysis to simulate the seismic response of geo-structures, and developing GIS-based liquefaction severity maps for regional assessments. We are also finding various ways to mitigate the impact of soil liquefaction on the built environment, specifically the use of novel and sustainable materials as liquefaction countermeasures.
Keywords: soil liquefaction; soil dynamics; earthquake geotechnical engineering

Professor J.E. (Kobus) van Zyl (k.vanZyl@auckland.ac.nz)
Water distribution systems, including hydraulic network theory, reliability of bulk supply systems, water demand modelling, water metering, the behaviour of pipe leaks and soil-leak interaction. Collaborative and transdisciplinary research on infrastructure.
Keywords: water distribution systems; water supply; leakage; water demand; hydraulic modelling; infrastructure

- ***Department of Electrical, Computer, and Software Engineering***

Project: Software Engineering (Software Design, Principles, Code Smells, Metrics)
PhD candidates interested in studying design aspects of software engineering, including but not limited to design principles, metrics, measurements, and code smells. I am also interested in supervising projects on how software engineering principles and lifecycle apply in the context of machine learning-based software systems.
Contact: Dr Reza Shahamiri (reza.shahamiri@auckland.ac.nz)
Keywords: software engineering; software design; software measurements; artificial intelligence

Project: Autism AI: detection of autism spectrum disorder based on artificial Intelligence Techniques
Autistic spectrum disorder (ASD) is a neurodevelopment condition normally linked with substantial healthcare costs and time-consuming assessments where early detection of ASD traits can help limit the development of the condition. The mean age of diagnosis in NZ is 6-7 years, which is 2-3 years after families/carers expressed their initial concerns. The optimal window for delivering treatment to children with ASD is at 2-3 years, which necessitates identification before the child turns two. In addition to being time consuming, clinical diagnosis has accessibility issues and relies on clinical judgment. This project will design and implement an artificial intelligence-based (AI) software system to enable quick, accurate, and accessible detection of autistic traits in individuals by utilizing multiple machine and deep learning modules.
Contact: Dr Reza Shahamiri (reza.shahamiri@auckland.ac.nz)
Keywords: artificial intelligence; autism

Project: Deep learning-based automated software test oracles for complex systems
Test oracle is a mechanism to determine whether an application is executed correctly. It is a reliable source of how the SUT (Software Under Test) must operate. It is also expected to provide correct results for any inputs that are specified by the software specifications, and a comparator to verify the actual behaviour. Automated test oracles are helpful in providing an adequate automated testing framework. In this project we would like to explore how deep learning-based supervised, unsupervised, or reinforcement learning algorithms can be used to facilitate the design and implementation of complex software test oracles to help reduce the difficulties and complexities of testing difficult-to-test software systems.
Contact: Dr Reza Shahamiri (reza.shahamiri@auckland.ac.nz)
Keywords: software testing; software test oracle; deep learning

Project: Impaired automatic speech recognition
Automatic speech recognition (ASR) can be very helpful for speakers who suffer from dysarthria, a neurological disability that damages the control of motor speech articulators. ASR can act as a medium to not only understand the impaired speech but also to talk on the speaker's behalf and enable them to have a better social and digital life. Current speech recognition systems have not been able to understand dysarthric speech, leaving speech impaired individuals not being able to utilise ASR technologies that could be life changing for them. In this project our ultimate aim is to enable

computers to understand dysarthric speech, using deep and machine learning technologies.
Contact: Dr Reza Shahamiri (reza.shahamiri@auckland.ac.nz)
Keywords: dysarthria; dysarthric speech recognition; deep learning

Project: Automatic early detection of alzheimer's dementia individuals using speech and language technologies
The cognitive impairment of the elderly is of great concern for the ageing population and the healthcare systems worldwide. This project will investigate and design an artificial intelligence system that can automatically detect dementia individuals in the early stage using deep learning-based speech and language technologies. Given there is no cure, early detection of Alzheimer's Dementia is one of the most important interventions for the management of dementia and could have a significant impact on the lives of dementia patients. We have multiple opportunities for researchers to study this topic.
Contact: Dr Reza Shahamiri (reza.shahamiri@auckland.ac.nz)
Keywords: dementia; deep learning; speech and language processing

Project: Applications of artificial intelligence and machine learning to improve software engineering processes and products
Artificial Intelligence algorithms in general, and machine learning more specifically, have had noticeable impacts on multiple engineering disciplines. From robotics to health care, we have seen many new areas of products and services. We intend to advance software engineering by studying how machine and deep learning methods can provide further automation for software developers, end-users, and other stakeholders to improve activities involved in the Software Development Life Cycle, to potentially improve both the process of developing software systems and software products. You can study ways to automate different software design activities, analyse metrics, verify and validate code etc.
Contact: Dr Reza Shahamiri (reza.shahamiri@auckland.ac.nz)
Keywords: software engineering; machine learning; deep learning

Associate Professor Nirmal Nair (n.nair@auckland.ac.nz)
I am interested in supervising projects that involve smart grids, power system analysis, protective relaying, and optimisation in the context of electricity markets and integration of DG/renewable sources into electricity networks. My research interests span power systems in the context of protective relaying, electricity markets, voltage security, blackouts, and resilience. My current focus is towards integration of distributed/renewable energy sources to electricity system with emphasis on protection (IEC 61850, SPS, WAPS), energy markets (block-chain), innovations (Micro-grid, Storage, EV & PV integration, cyber-resilience, digital twins, machine learning and AI), low-carbon transitions and energy policy.
Keywords: electricity; renewables; power systems; blackouts; smart grid; sustainability; energy policy; ICT

Dr. Reza Shahamiri (reza.shahamiri@auckland.ac.nz)
I am a deep learning software engineer who wants to leverage technological advancements in computing and artificial intelligence to address health disparities. My primary focus is on developing smart assistive technologies, constructing intelligent software platforms and solutions that enhance support for individuals with mental or physical limitations, and equipping healthcare professionals with advanced tools and

equipment. My research revolves around creating innovative and intelligent healthcare systems, utilizing deep learning technologies, speech and speaker identification, and automation of software test oracles. I am also interested in how software engineering principles and processes could be tailored to design more robust software products that utilize machine learning algorithms. I am currently accepting PhD students interested in any of these areas. Please refer to my university profile page for the list of available PhD projects, or feel free to propose your own related PhD topic.
Keywords: deep learning; software engineering; health AI; speech and language processing; dysarthria; dementia, autism

Associate Professor Oliver Sinnen (o.sinnen@auckland.ac.nz)
Working in the domains of Software Engineering, Computer Systems Engineering and Computer Science, my research focuses on parallel computing and high-performance computing. I supervise work in scheduling, algorithm design and optimisation for parallel computing systems, reconfigurable computing with FPGAs and space related research, e.g. high performance computing in satellites, radio astronomy algorithms and telescope scheduling. Please consult my profile page for current projects.
Keywords: parallel computing; high performance computing; algorithm design; reconfigurable computing; FPGAs; radio astronomy algorithms; telescope scheduling; computing in satellites

- ***Department of Mechanical and Mechatronics Engineering***

Project: Shaping a circular market system for plastics in NZ
New Zealand's size and distributed population base restricts cost effective recycling of plastics to a few polymer types and consigns the majority of plastic waste to our landfills. This project is part of a multi-disciplinary program focussed on novel treatment, production, and design methods to re-manufacture collected plastic, and the circular economy that will drive the reduction of plastic waste in New Zealand.
Over a 5-year period one stream of the research will utilise plasma treatment to modify thermoplastic polymers, and blend polymer blends, to create high value blended materials and thermoplastic composites.
We will investigate the application of plasma treatments to thermoplastic melts during processing, thereby modifying the bulk material as opposed to only the surface. The focus of the project will be to design a system that can be used during extrusion of single polymer systems but under different atmospheres, thereby controlling the type of functionality added to the polymer. Furthermore, we will develop equipment that can monitor the composition of the plasma, giving us an even better understanding of the process and a mechanism for process control.
Within the Centre for Advanced Materials Manufacturing and Design, our researchers and experts develop innovative scientific technologies around three main domains:

- *Novel Materials:* Research into novel materials, including micro- and nano-fibrillar composites and high performance biocomposites.
- *Manufacturing Processes:* Research into processes such as liquid reactive compounding, liquid composite moulding, prepreg consolidation, extrusion, injection moulding and rotomoulding.
- *Structural Performances:* Analysis and experimental characterisation of performance, including failure prediction, dynamic loading effects, product design and applications.

Contact:
Professor Johan Verbeek (johan.verbeek@auckland.ac.nz)
Professor Simon Bickerton (s.bickerton@auckland.ac.nz)
www.cammd.co.nz
Keywords: circular economy; plastics; reactive compounding; recycling; thermoplastic composites; sustainability

Project: Turbulent flows over rough and porous media
Turbulent flows passing over rough surfaces and porous media are ubiquitous in engineering and geophysical applications. Examples include the wind blowing over a forest canopy, a river flowing over a gravel bed or water flowing around a barnacle-encrusted ship's hull. The surface roughness and permeability have wide implications on weather and climate in geophysics or drag (and therefore energy/fuel expenditure) in engineering yet remain poorly understood. This project will use a novel, efficient high-fidelity direct numerical simulation (DNS) technique, a form of Computational Fluid Dynamics (CFD) to study these flows. The goal is to increase our physical understanding of the turbulence. This will pave the way toward more accurate models that predict quantities of interest such as drag or skin friction.
Contact: Dr Michael MacDonald (michael.macdonald@auckland.ac.nz)
Keywords: fluid mechanics; computational fluid dynamics (CFD); turbulence; boundary layers

Project: Investigating the intricacies of the internal boundary layer
The turbulent atmospheric boundary layer, the lowermost few kilometres of the atmosphere, is fundamentally dependent on the underlying ground conditions. Abrupt changes in ground conditions generate complex Internal Boundary Layers (IBLs) as the atmospheric flow adjusts to the new surface. These changes can be caused by localised releases of pollution from cars or chimneys, or changes in ground roughness such as at forest or city edges. Predicting the height and growth of the IBL is critical for estimating building wind loads, meteorological conditions, and climate change effects. This project will study IBLs using advanced high-fidelity computational fluid dynamics (CFD) simulations. This will increase our understanding of the essential physical makeup of the IBL, enabling more accurate turbulence, weather, and climate models to be developed.
Contact: Dr Michael MacDonald (michael.macdonald@auckland.ac.nz)
Keywords: fluid mechanics; computational fluid dynamics (CFD); turbulence; boundary layers

Project: Tidal energy for powering marine aquaculture farms
Marine farming of aquaculture is one of the fastest growing industries in New Zealand and globally. It requires a resilient supply of clean and cheap electrical energy. Tidal energy conversion has great potential for supplying current and future energy needs of the marine farming industry and provides an opportunity to grow the global economy. Previously, there have been attempts to use solar energy for aquafarming needs, however the cost-effectiveness has been inconsistent and solar panels require frequent maintaining and replacing. Tidal energy is a more continual source of energy and has much higher energy density compared to solar. The aim of the project is to develop a novel tidal energy converter that will generate electricity at commercially required power levels for marine farming (up to 1KWatt) with high probability and reliability. The converter should be compatible with conventional floating structures used in marine farming and be easy to manufacture, deploy and maintain.

What we are looking for in a successful applicant: theoretical background in dynamics and fluid-structure interaction; experience in Matlab and/or ANSYS

Contact:

Dr Vladislav Sorokin (v.sorokin@auckland.ac.nz)
Kean Aw (k.aw@auckland.ac.nz)
Colin Whittaker (c.whittaker@auckland.ac.nz)

Keywords: marine energy; aquaculture; tidal energy; marine farming; fluid-structure interaction

Project: Tribo-electro-magnetic generator for wave energy converters

The energy density of ocean waves (1 – 3 kW/m^2) is much higher than that of other renewable sources, such as wind (0.4 – 0.6 kW/m^2) and solar (0.1 – 0.2 kW/m^2). Waves can generate power 80% of the time vs 20-30% for solar and wind. However, efficient wave energy conversion is a challenging scientific problem since waves are low-frequency and irregular in period and height. This project aims to develop a novel tribo-electro-magnetic generator, utilizing the benefits of combined triboelectric and electromagnetic transduction, to effectively convert the motion of the waves into useable electrical power.

Triboelectric energy conversion features higher efficiency than conventional electromagnetic or hydraulic conversion(70% versus 20-30% efficiency), especially at low frequencies and low amplitudes of motions. Applications of this technology to renewable energy are rapidly developing. However, electrical current output of triboelectric energy converters is typically relatively low (mA range and below), limiting the use of the technology. Combining triboelectric and electromagnetic energy conversion in one device can potentially provide a solution to this and will be studied in the project. In particular, the project implies developing a novel energy management circuit for the tribo-electro-magnetic generator, considering the electrical impedance mismatch between the typical triboelectric and electromagnetic systems, to achieve higher electrical current output.

Requirements: background in electronics and dynamics; experience in Matlab and/or ANSYS

Contact: Dr Vladislav Sorokin (v.sorokin@auckland.ac.nz)
Kean Aw (k.aw@auckland.ac.nz)

Keywords: marine energy; triboelectricity; electromagnetic transduction; wave energy; energy management circuit

Project: Thermal metamaterials with advanced heat transfer properties

Artificially structured materials have received significant interest in recent years, primarily because of their broad range of applications. These "metamaterials" have been successfully exploited to control sound and vibration transmission. The phenomenon of heat transfer has always been of great practical importance and recently there have been attempts to develop and utilize metamaterials for manipulating, controlling, and processing the flow of heat. Thermal metamaterials can have amazing properties in heat transfer beyond naturally occurring materials owing to their well-designed artificial structures. However, there are still many challenges for effective design of thermal metamaterials, especially related to their practical realisation and experimental testing and tuning.

The research idea of this project is to develop a robust and easy to manufacture thermal metamaterial with advanced heat transfer properties that can enable, for example,

improved flow of heat. To achieve the advanced properties, it is proposed to introduce periodic variations of the metamaterial parameters at the microscale level and study the influence on these variations on the heat transfer at the macroscale level. The project aims to theoretically analyse and optimize the performance of thermal metamaterials and then experimentally test the metamaterials to illustrate and tune their extraordinary heat transfer properties.
Requirements: Background in theoretical and experimental analysis of dynamics and vibrations and heat transfer
Contact: Dr Vladislav Sorokin (v.sorokin@auckland.ac.nz)
Keywords: metamaterials; heat transfer; periodic structure; flow of heat; microscale

Dr Michael MacDonald (michael.macdonald@auckland.ac.nz)
I am interested in the numerical simulation of turbulent heat and fluid flows, including both fundamental studies and their application to geophysical and engineering flows. My research aims to uncover the essential ingredients of turbulence, enabling more efficient numerical simulations to be performed.
Keywords: fluid mechanics; computational fluid dynamics (CFD); turbulence; boundary layers; aerodynamics; heat transfer

- ***Department of Chemical and Materials Engineering***

Project: Superheated steam spray drying of heat sensitive milk powder
Milk powder spray drying involves spraying liquid milk into hot air which dehydrates the milk droplets into dry powder. There is a lot of potential for energy saving to replace the hot air with superheated steam. This is mainly due to the condensation phenomenon of superheated steam. The use of superheated steam will also provide a zero-oxidation environment which prevents the oxidation of the dairy powder. One main challenge in using superheated steam for dairy powder drying is in the low thermal stability of milk products. Reports from the literature suggest that the sudden cooling of the milk powder after superheated steam drying may provide the potential to preserve the integrity of the milk powder. In this project, we will explore suitable sudden cooling strategies to achieve good quality superheated steam spray dried milk powder. We will deliver a proof-of-concept lab-scale superheated steam spray dryer for milk powder. This project will be undertaken as an inter-disciplinary project between the Faculty of Engineering and the Faculty of Science (Food Science).
Contact: Associate Professor Meng Wai Woo (wai.woo@auckland.ac.nz)
Keywords: food powder; spray drying; superheated steam; milk powder; dairy processing

The supervisors listed in this booklet are just a few of the many supervisors and research projects suitable for doctoral study in the Faculty of Law at the University of Auckland. For information about other areas of active research in which it might be possible to undertake doctoral studies, see the following webpage:

Doctoral study in Law

Associate Professor Treasa Dunworth (t.dunworth@auckland.ac.nz)
I am particularly interested in matters of disarmament and arms control as a sub-set of my broader interest in matters of international peace and security. I am keen to supervise in matters relating to the work and agenda of the Non Aligned Movement (NAM), historically and in terms of contemporary work.
Keywords: security; non-aligned movement; disarmament; arms control

Professor Jodi Gardner (jodi.gardner@auckland.ac.nz)
I am very interested in supervising a project on Indonesian credit laws, particularly the impact of sharia law on the banking and finance system in the country.
Keywords: contract law; consumer law; consumer credit law; sharia law

Dr An Hertogen (an.hertogen@auckland.ac.nz)
I have capacity to supervise on topics of international economic law, particularly international trade law, and on general questions of the scope of state sovereignty in international law.
Keywords: international economic law; international law

Professor Mark Henaghan (mark.henaghan@auckland.ac.nz)
I have capacity to supervise in the areas of international child abduction; disputes over international property; ideologies of family law; and questions as to whether family law should be private or public in both its processes and application.
Keywords: family law

Dr Arie Rosen (a.rosen@auckland.ac.nz)
I am interested in supervising candidates on questions concerning the politics of private law, particularly projects examining the relationship between political theory, political institutions, and the development of private law.
Keywords: private law theory; the politics of private law

Professor Warren Swain (w.swain@auckland.ac.nz)
I am interested in supervising on the history and modern law relating to contract, tort, unjust enrichment, and aspects of Equity and consumer law.
Keywords: legal history; contract law; tort law; unjust enrichment; comparative law

Professor Julia Tolmie (j.tolmie@auckland.ac.nz)
I have capacity to take on supervisions in criminal law, family law and feminist legal jurisprudence. A theme throughout my research has been how the law understands, constructs and responds to precarity - particularly in the lives of women.
Keywords: criminal law and policy; feminist legal jurisprudence; family violence

Associate Professor Hanna Wilberg (h.wilberg@auckland.ac.nz)
The main areas of my research are Administrative Law, Judicial Review of Administrative Action, Administrative Justice, Social Security Law, Tort Liability of Public Authorities. I am available to supervise in all of these areas.

UNIVERSITY OF AUCKLAND
Waipapa Taumata Rau
NEW ZEALAND

MEDICAL AND HEALTH SCIENCES

The projects listed in this booklet are just a few of the many possible research projects suitable for doctoral study in the Faculty of Medical and Health Sciences at the University of Auckland. For information about other areas of active research in which it might be possible to undertake doctoral studies, see the following webpage:

Doctoral study at FMHS

- **Anaesthesiology**
- **Anatomy**
- **Audiology**
- **General Practice**
- **Health Sciences**
- **Maori and Pacific Health**
- **Medical Imaging**
- **Medicine**
- **Molecular Medicine**
- **Nursing**
- **Optometry**
- **Pathology**
- **Pharmacology**
- **Pharmacy**
- **Physiology**
- **Surgery**

Project: Novel procedures for testing and reducing vision defects
Perceptual dysfunction and vision loss occur in many disorders, ranging from eye diseases like glaucoma, neurological disorders like Alzheimer's or Parkinson's Disease, to stroke and head trauma. Commonly used procedures for mapping vision problems can lack reliability and are often tedious, resulting in patient fatigue and reduced task compliance. My lab is developing novel behavioural procedures for measuring vision loss and perceptual anomalies. We also develop 'gamified' tasks to train patients to use their affected visual field and thus reduce the extent of blindness. Further down the line, we aim to adapt these designs for simultaneous physiological measurements (e.g., electroencephalography or eye tracking) to make measurements independent of behavioural tasks. This would make the tests more objective and amenable for use in patients whose ability to perform behavioural tasks is compromised. Finally, we are also seeking to use functional MRI for these purposes, and this could be part of a PhD project if funding is available at the time.
Contact: Associate Professor Sam Schwarzkopf (s.schwarzkopf@auckland.ac.nz)
Keywords: vision loss; scotomas; perimetry; methods development

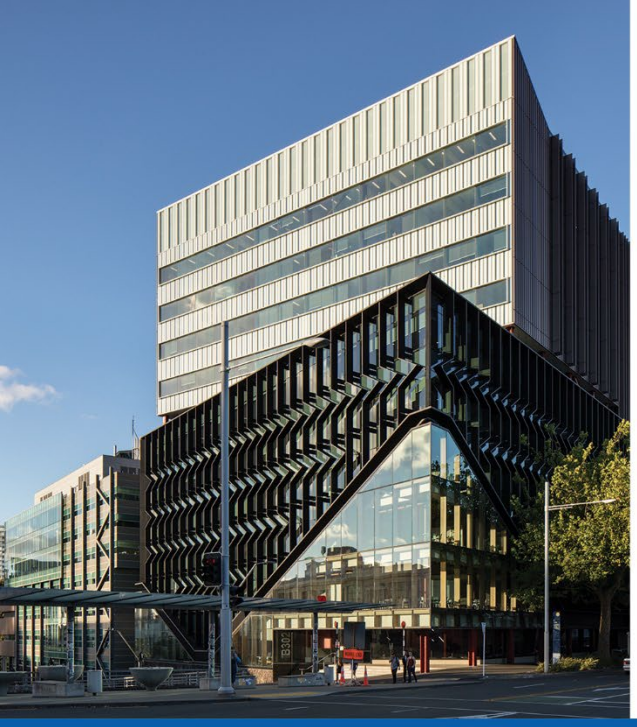
Project: Interplay of perception and behaviour/cognition
It remains controversial regarding the extent to which visual perception can influence people's behaviour. My lab seeks to better understand this using a range of behavioural techniques. We use virtual reality (collaborations with Phil Turnbull and/or Chris Erb at UoA, or with Philippe Chouinard at La Trobe University in Melbourne), conventional lab experiments, or experiments in real world situations like dart-throwing. Besides the scientific knowledge gained from these studies, this research has practical implications, such as creating novel training solutions (e.g., for athletes, surgeons, architects) and improving road safety by modulating the perception of driving speed. It may also help inform theory by revealing psychiatric or developmental conditions (e.g., schizophrenia or autism) where the link between perceptual experience and cognitive decisions is atypical.
Contact: Associate Professor Sam Schwarzkopf (s.schwarzkopf@auckland.ac.nz)
Keywords: perceptual illusions; virtual reality; cognition; bias; action

Project: Understanding the mechanisms underlying visual perception
A long-standing goal of our research is to better understand the neural mechanisms underlying subjective visual perception. So far, most of the investigations have focused on the perception of visual object size. Despite being a fundamental part of our interactions with the world around us, how the brain infers the size of objects remains poorly understood. However, similar research questions apply to perceiving speed, orientation, blur, or object identity, to name a few. This project therefore provides a great degree of flexibility. Primarily, these studies will use conventional psychophysical procedures, or novel methods we are developing. There is also an opportunity to use EEG (in collaboration with Paul Corballis (UoA Psychology) and/or Luke Hallum (UoA Engineering). If funding is available, this project can also include functional MRI experiments.
Contact: Associate Professor Sam Schwarzkopf (s.schwarzkopf@auckland.ac.nz)
Keywords: spatial vision; subjective perception; contextual modulation; psychophysics

Project: Use of traditional, complementary, and alternative medicines among Indonesian people living in New Zealand
This project will explore the extent of use, access to, expenditure on and experiences with traditional, complementary, and alternative medicines by Indonesian people living in New Zealand. It will use quantitative (structured questionnaire) and qualitative (interviews) methods.
Contact: Professor Jo Barnes (j.barnes@auckland.ac.nz)
Keywords: herbal medicines; traditional medicines; complementary/alternative medicines; natural health products; drug utilisation research; healthcare utilisation; prevalence

Dr Ryan San Diego (r.sandiego@auckland.ac.nz)
I am interested in how people make sense of their health and illness in clinical and non-clinical contexts (phenomenology of health & well-being), how children and young people are impacted by their developmental conditions and how they regulate themselves (child and youth mental health). Why do people develop addictive behaviours and what are their experiences recovering from it (psychology of mental health and addictive behaviours) and how do mental health professionals gain competencies and work through various tensions in their practice settings (psychological practice).
Keywords: mental health services; psychological methodology, design and analysis; counselling psychology; clinical neuropsychology; multicultural, intercultural and cross-cultural studies; social determinants of health; applied and developmental psychology; child and adolescent development; health psychology

Professor Jo Barnes (j.barnes@auckland.ac.nz)
Professor in Herbal Medicines, School of Pharmacy, . I have interests in the use of traditional, complementary and alternative medicines among Indonesian people living in New Zealand
Keywords: herbal medicines; traditional medicines; complementary/alternative medicines; natural health products; pharmacovigilance / drug safety monitoring



UNIVERSITY OF AUCKLAND
Waipapa Taumata Rau
NEW ZEALAND

SCIENCE

The projects listed in this booklet are just a few of the many possible research projects suitable for doctoral study in the Faculty of Science at the University of Auckland. For information about other areas of active research in which it might be possible to undertake doctoral studies, see the following webpages:

- **Doctoral study in Biological Sciences**
- **Doctoral study in Chemistry**
- **Doctoral study in Computer Science**
- **Doctoral study in Environmental Science**
- **Doctoral study in Exercise Sciences**
- **Doctoral study in Food Science**
- **Doctoral study in Forensic Science**
- **Doctoral study in Geography**
- **Doctoral study in Geology**
- **Doctoral study in Marine Science**
- **Doctoral study in Mathematics**
- **Doctoral study in Mathematics Education**
- **Doctoral study in Physics**
- **Doctoral study in Psychology**
- **Doctoral study in Speech Science**
- **Doctoral study in Statistics**

- ***School of Biological Sciences***

Project: Flagellum phylogenetics
The bacterial flagellum is a biochemical nanomachine that allows bacteria to swim at high speed. Its function requires the interaction of dozens of different proteins. We are reconstructing the evolutionary origins of this system, protein-by-protein, using advanced methods in homology detection and phylogenetics, including exploration of phylogenetic inferences informed by protein structure information. Each protein or subcomponent provides a project that will contribute to the overall synthesis of the coevolution of all components.
Contact: Dr Nicholas J. Matzke (n.matzke@auckland.ac.nz)
Keywords: flagellum; evolution; homology; bioinformatics; phylogenetics

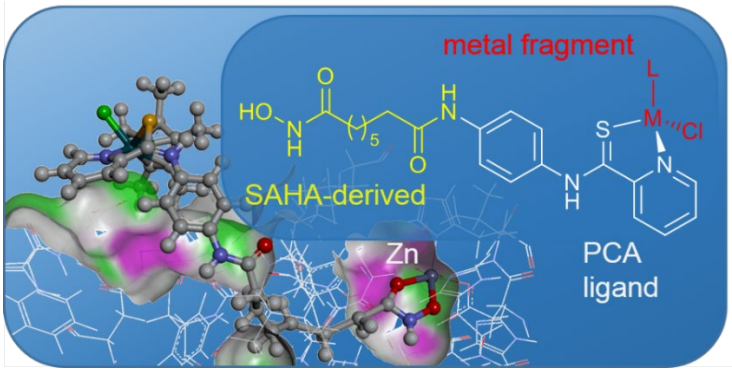
Project: Advanced models in phylogenetic biogeography
Our group has developed new models for inferring the biogeographic history of groups of species on dated phylogenetic trees. These methods can include changing paleogeography, paleoenvironment, organismal traits and, potentially, ecological interactions. Projects could include (1) advanced analyses on a study group that a student is already familiar with, for students with a strong organismal/systematics background; (2) developing new models and testing them against simulations and empirical datasets, for students with a strong computational/programming background. Main computer languages are R and Julia.
Contact: Dr Nicholas J. Matzke (n.matzke@auckland.ac.nz)
Keywords: biogeography; evolution; homology; bioinformatics; phylogenetics

Project: Bayesian phylodynamic inference from single-cell sequencing data
Progress in single-cell sequencing technologies means the field of phylodynamics, which combines the inference of evolutionary and population dynamic processes, is now applicable to cell and developmental biology. Phylodynamics promises to provide fundamental insights into somatic, evolutionary, and biomedical aspects of multicellular organisms. As a cell population grows, mutations (e.g., indels, single-nucleotide, copy number, structural, and epigenetic variants) act as markers of the evolutionary and developmental processes. Evolutionary models can provide insight into somatic development (e.g., cell growth rates) and cancer evolution (e.g., driver mutations, metastatic dissemination routes).
Applications are now invited for a fully funded PhD position in the exciting field of single-cell genomics and phylodynamics, which combines the realms of evolutionary biology, genomics, and computational biology. The project will involve developing Bayesian phylodynamic inference models for single-cell sequencing data, especially for studying cancer evolution. This opportunity will allow you to conduct innovative interdisciplinary research and collaborate with leading scientists in evolutionary biology.
The successful candidate will work under the supervision of Professor Alexei Drummond and Dr David Welch, in close collaboration with an international team of leading researchers including Professor David Posada at the University of Vigo in Spain, Professor Tanja Stadler at ETH Zurich in Switzerland, and Associate Professor Alex Gavryushkin at the University of Canterbury in New Zealand.
This interdisciplinary project aims to develop a unified Bayesian framework for joint single-nucleotide variant (SNV) and copy number variant (CNV) calling, phylogenetic, and population dynamic inference from single-cell sequencing data. You will be part of

the effort to create a comprehensive and statistically rigorous model that will address current gaps in single-cell genomics and cancer evolution.
Contact: Professor Alexei Drummond (a.drummond@auckland.ac.nz)
Keywords: single-cell sequencing; cancer evolution; somatic evolution; computational biology; single-nucleotide variant (SNV); copy number variant (CNV); Bayesian phylodynamics; phylogenetics

- ***School of Chemical Sciences***

Project: Metal-based anticancer agents: design, preparation and analysis of the modes of action of bioorganometallic chemotherapeutics
More than 50% of cancer patients receive platinum-based chemotherapeutics, and many more inorganic compounds are widely used in the diagnosis and treatment of other diseases. This is owed to their specific properties such as tunable ligand exchange reactions, redox activity, unpaired electrons, and/or radioactivity. Bioorganometallic chemistry, i.e., the chemistry of compounds featuring at least one metal-carbon bond, is a thriving field of research. In particular, the development of anticancer drugs based on organometallic moieties has received a lot of attention in recent years. While the modes of action of anticancer metallodrugs are crucially dependent on their interactions with biological molecules, we often lack an understanding of the targets and how the complexes are metabolized in a biological environment.
My group designs, synthesizes and studies new anticancer agents, often with bioactive co-ligands, and we develop analysis methods using high-end instrumentation to investigate their modes of action. We have several projects available in this area for students with an interest in synthetic and/or analytical chemistry and who have an interest in the drug development process in general.



Hartinger et al., Angew. Chem. 2020, 59(34), 14609
Contact: Professor Christian Hartinger (c.hartinger@auckland.ac.nz)
Keywords: anticancer drug development; organometallic chemistry; synthesis; bioanalytical chemistry; biological inorganic chemistry; targeted drugs; biomolecule binding

Project: Stimulus-responsive supramolecular structures for anticancer drug delivery

The formation of flexible supramolecular architectures in nature is key to the function of many biomolecules. Supramolecular structures arise from a defined number of building blocks that reversibly interact through weak forces (e.g., metal coordination, hydrogen bonding and electrostatic interactions), rather than by covalent bonds. Such interactions facilitate the formation of large, complex structures with specific biological functions. Inspired by this concept, synthetic supramolecular compounds based on metal complexes have been prepared (metallosupramolecular compounds) and have been used in catalysis, drug delivery, as ion sensors and as 'molecular containers'. However, most synthetic supramolecular compounds have been designed to be static. There are very few examples of specifically designed, discrete molecular containers with stimuli responsive architectures, as found in nature, and these are mostly limited to large, less easily controlled structures, such as functionalised cyclodextrins and polymers. We design, synthesize and study new supramolecular compounds that are responsive to pH, light and redox reactions. We use high-end analysis methods to investigate the binding of guest molecules to the supramolecules and we investigate their release, with a particular focus on the delivery to cancer cells. For this project, we are looking for motivated students with a background in synthetic chemistry.

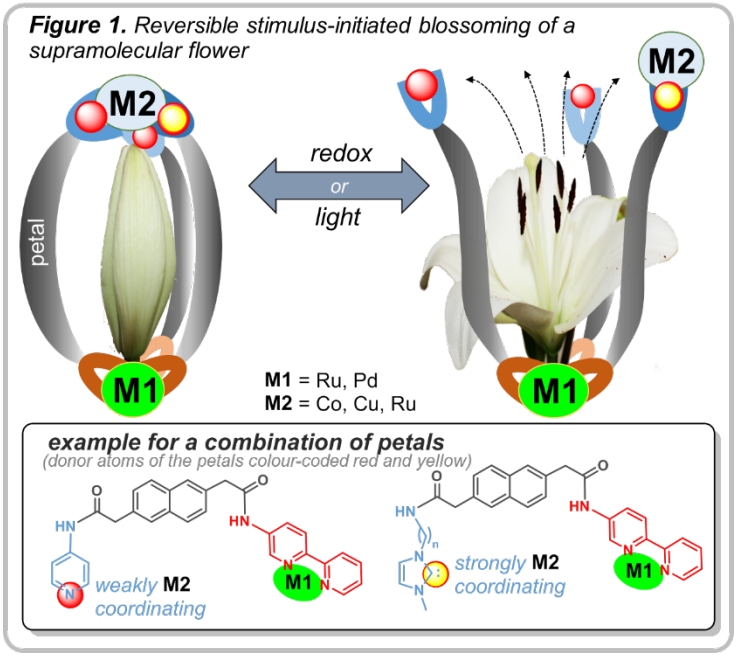


Figure 1. Reversible stimulus-initiated blossoming of a supramolecular flower

Contact: Professor Christian Hartinger (c.hartinger@auckland.ac.nz)

Keywords: supramolecular chemistry; synthesis; stimulus-responsive structures; protein-protein interaction inhibitors; protein interactions; drug delivery; host-guest binding

https://hartinger.wordpress.fos.auckland.ac.nz/marsden-project/

Project: Synthesis of biologically active lignan natural products

Lignans are a class of compound which has become the target of particular interest to researchers, owing to their numerous biological activities including anti-cancer and cytotoxic properties and have also shown an array of pharmacological activities, including antifungal, antibacterial, antioxidant and anti-proliferative properties. In this project we will explore our recently developed methods to prepare a range of classes of lignan natural products using a common, easily made intermediate. This compound can be converted to both THF lignans and aryl-tetralin lignans, both classes having highly bioactive members including clinically used drugs. The student undertaking this project will be involved in organic synthesis, purification, and compound characterisation (NMR, MS, IR, etc). They should have a reasonable knowledge of synthetic chemistry.

Contact: Professor David Barker (d.barker@auckland.ac.nz)

Keywords: organic chemistry; synthesis; natural products

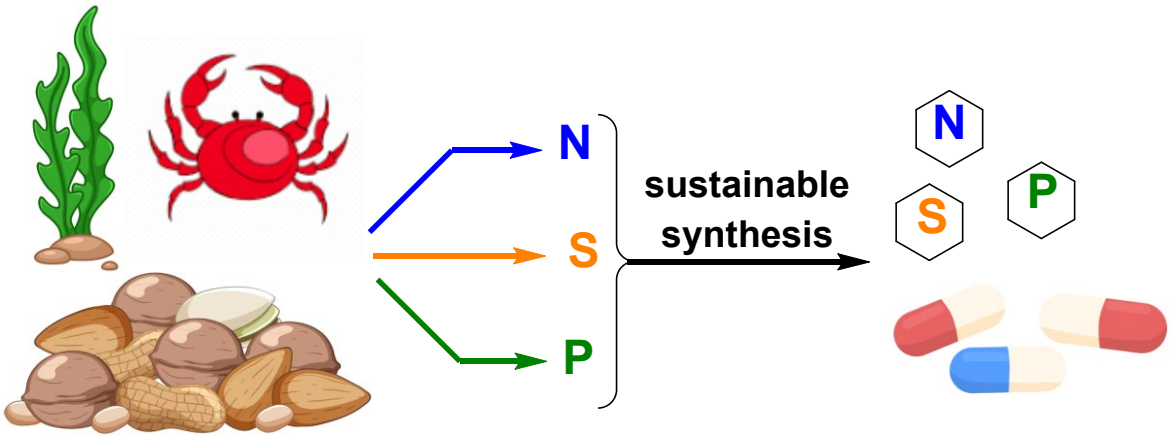
Project: Synthesis of Novel inhibitors of Phospholipase C, an enzyme involved in cancer cell proliferation
Phospholipase C is a promising biological target for anticancer drug therapy with compounds binding to PLC showing marked growth inhibition of haematological tumour cells. We have recently discovered a class of compounds which are potent inhibitors of cell growth. Morphology and motility assays using triple negative breast cancer cell lines lead to the conclusion that PLC is the most probable bio-molecular target of these compounds, however other important targets may be affected. The student working on this project will be involved in the design (computation modelling), synthesis and biological testing of novel compounds to treat cancer. Students with an interest in organic or medicinal chemistry are encouraged to apply.
Contact: Professor David Barker (d.barker@auckland.ac.nz)
Keywords: cancer treatments; medicinal chemistry; synthesis

Project: Synthesis of novel bio-based materials for water purification
One of the world's biggest challenges is pollution of fresh waterways. Two of the main pollutants that are plaguing our freshwater are nitrates and heavy metals, high levels of which have been shown to cause significant health and environmental problems. The primary aim of this project is to develop new filter materials using all natural, bio-based, compounds that will be able to purify water through the removal of damaging pollutants. This new technology will combine knowledge from areas of synthetic chemistry, polymeric materials, and membrane science to produce a material capable of reducing toxins in fresh water.
Contact: Professor David Barker (d.barker@auckland.ac.nz)
Keywords: green chemistry; materials chemistry; pollution

Project: Synthesis of DNA binding trioxatriangulenium analogues
Trioxatriangulenium (TOTA) ions are highly stabilised planar carbocations that have excellent DNA intercalating properties. Interestingly, these molecules can change shape from the bioactive flat form to an inactive umbrella form in a reversible manner meaning that they can become activated within cancer cells alone. We have recently discovered that these compounds inhibit the growth of numerous cancers at nanomolar dosages but are limited in their activity by their overall solubility. In this project, we will prepare novel TOTA analogues that have solubilising groups and are conjugated to other DNA binding anticancer agents. The aim is to prepare soluble derivatives with increased bioactivity. The student working on this project will be involved in the design (computation modelling), synthesis and biological testing of novel compounds to treat cancer.
Contact: Professor David Barker (d.barker@auckland.ac.nz)
Keywords: cancer treatments; medicinal chemistry; synthesis

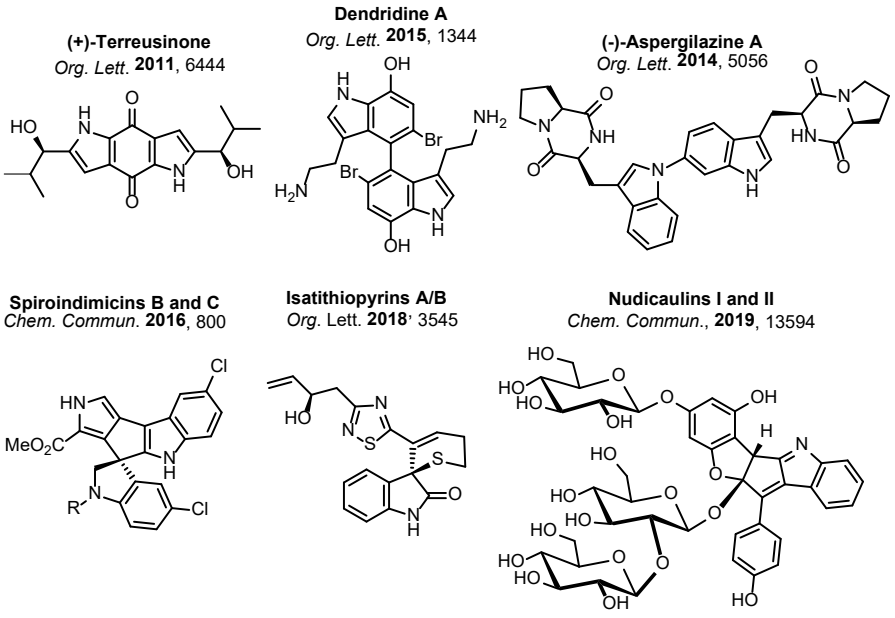
Project: Sustainable synthesis of heteroatom-based fine chemicals
The global chemical industry is committed to reducing the carbon footprint embedded within its supply chains. While a large amount of attention has focused on the production of bio-based compounds that contain C, H, and O from lignocellulosic biomass, advancing valuable heteroatoms such a nitrogen (N), sulphur (S) and phosphorus (P) from biogenic sources into valuable fine chemicals has received much less attention. This project will investigate the synthesis of fine chemicals from platform molecules available

from reservoirs of biogenic heteroatoms, such as chitin (N), fucoidan (S) and phytic acid (P).



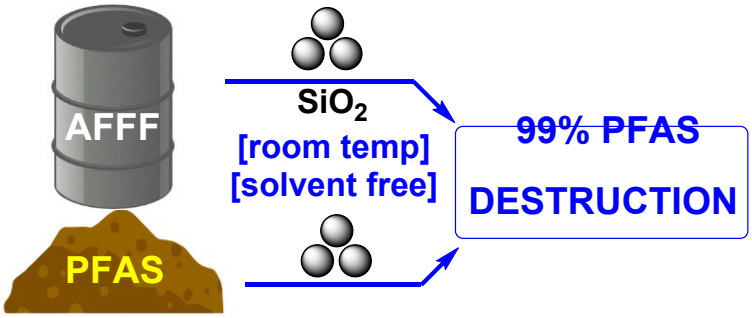
Green Chem. **2023**, DOI 10.1039/D3GC01421E; Phil. Trans. Roy. Soc. A. **2021**, 379, 20200350; Green Chem. **2020**, 22, 1978; ChemSusChem. **2018**, 11, 532-535; Green Chem. **2016**, 18, 2453-2459; Green *Chem*. **2014**, 16, 2084
Contact: Professor Jonathan Sperry (j.sperry@auckland.ac.nz)
Keywords: green chemistry; organic synthesis; sustainability; synthetic chemistry

Project: Total synthesis of indole alkaloids as lead compounds for CNS disease
This research project will focus on alkaloids that contain the indole heterocycle, a class of natural products that have an excellent reputation for crossing the blood-brain-barrier (BBB) and thus constitute excellent leads for the development of neuropsychiatric medications. In this ongoing project, we will embark on the total synthesis of a selected indole alkaloid that is available in small quantities from the natural source, using the novel scaffold as a platform for new synthetic chemistry method development. The synthetic sample will be tested for activity in the CNS with collaborators in the United States. Some completed natural product targets are shown below, many of which have subsequently been shown to possess interesting properties in the central nervous system that has led to spin-off medicinal chemistry studies.



Contact: Professor Jonathan Sperry (j.sperry@auckland.ac.nz)
Keywords: organic synthesis; natural products; synthetic chemistry; medicinal chemistry; alkaloid
https://www.organic-chemistry.org/Highlights/2012/09July.shtm
https://www.chemistryworld.com/news/biomimetic-synthesis-cultivates-yellow-poppy-pigment/4010602.article

Project: Mechanochemical destruction of 'forever chemicals'
Per- and polyfluoroalkyl substances (PFASs) are a class of synthetic chemicals of concern that exhibit extreme persistence within the environment and physicochemical properties that are resistant to targeted degradation. Comprising substantial concentrations of PFASs, aqueous film-forming foams (AFFFs) present a major exposure pathway to the environment having been applied to land at firefighting-training sites globally for decades. This has led to significant contamination of environmental media, which has negatively impacted the health of communities within the vicinity of these facilities. We have demonstrated that mechanochemical destruction (MCD) is an effective method for destruction of PFASs in an AFFF concentrate and an authentic sample of PFAS-contaminated soil derived from a decommissioned firefighting training facility. This process operates in the absence of solvent, at ambient temperature and pressure, and generates a benign, solid waste stream. This project will involve extending this technology to further real life-PFAS samples, validating this technology for scale-up and industrial implementation. This research project also involves working closely with the company Environmental Decontamination Limited (EDL) and the United States Environmental Protection Agency (USEPA)



Environ. Sci. Adv. **2023**, 2, 982; Environ. Sci. Tech., **2023**, 57, 277.
Contact:
Professor Jonathan Sperry (j.sperry@auckland.ac.nz)
Dr Kapish Gobindlal (kgob004@aucklanduni.ac.nz)
Keywords: mechanochemistry; PFAS; environmental remediation; environmental chemistry

Project: Design and synthesis of new generation norovirus protease inhibitors
Norovirus infection is the most common cause of acute gastroenteritis globally. In 2022, the World Health Organization estimated that 685 million cases of norovirus infections are observed annually, with an associated cost of $60 billion USD, and 200,000 deaths per year. There is currently no effective treatment against noroviruses which, combined with their highly infectious and contagious character, makes norovirus outbreaks particularly problematic in rest homes and hospitals.
The virus-encoded non-structural protein NS6pro (3C-like cysteine protease, 3CLpro) plays an essential role in the norovirus replication process while presenting minimal

homology to mammal proteases. This project aims to develop inhibitors of NS6pro that mimic the natural substrate for the treatment of viral infections. As part of a highly collaborative network, the synthetic chemistry work, which will include organic synthesis as well as solution-phase and solid-phase peptide synthesis, will be supported by molecular modelling, antiviral activity assays and crystallographic studies.

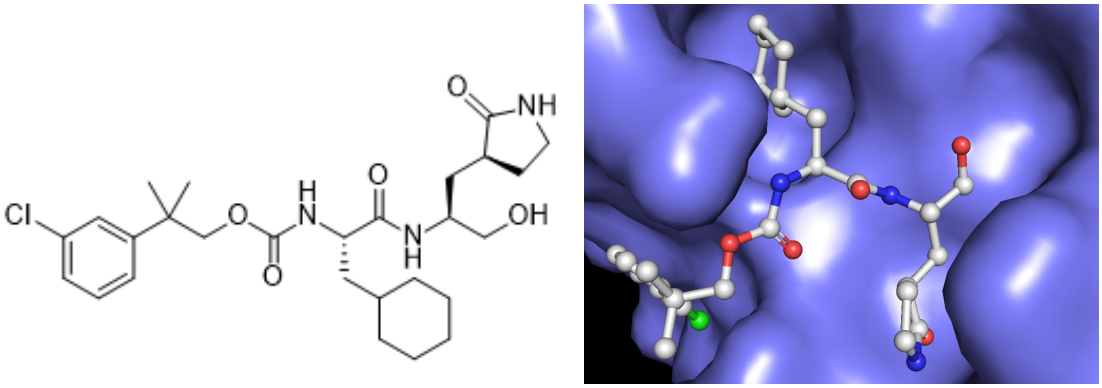


Figure 1. Example of peptidomimetic norovirus protease inhibitor[1]. Left: 2D chemical structure. Right: crystal structure of the inhibitor bound in the active site of norovirus $NS6^{pro}$ (image generated on PyMol).
Reference: [1] Groutas et. al., J. Med. Chem. **2020**, 63, 11945-11963. PDB: 6W5H

Contact:
Distinguished Professor Margaret Brimble (m.brimble@auckland.ac.nz)
Dr. Y. Hermant (yann.hermant@auckland.ac.nz)
Keywords: norovirus; viral infections; protease inhibitors; medicinal chemistry; peptidomimetics

Project: Asymmetric synthesis of biologically active spiroketal natural products
In 2022, Voratins A–C were isolated from the symbiotic marine dinoflagellate Effrenium voratum associated with the coral Alveopora japonica collected at Jeju, South Korea. These compounds proved to exhibit therapeutic effects against benign prostatic hyperplasia, as evaluated using testosterone propionate-treated LNCap and RWPE-1 human prostate cells. All three natural products are zwitterionic pyridinium alkaloids and contain a spiroketal moiety - a structural motif of particular interest to our group. Creating synthetic paths to these complex metabolites and constructing derivative libraries is critical to unlocking their potential as therapeutic leads. The student undertaking this project will focus on the development of novel access to secure the necessary chiral building blocks - the dihydroindolizinium ring and the spiroketal motif - and thus the construction of the carbon skeleton. This work will lay a robust foundation for comprehensive exploration into the medicinal potential of both the natural products and their synthetic derivatives. Students with an interest in organic synthesis and medicinal chemistry are encouraged to apply.

Contact:
Distinguished Professor Margaret Brimble (m.brimble@auckland.ac.nz)
Dr Freda Li (freda.li@auckland.ac.nz)
Keywords: organic chemistry; asymmetric spiroketal synthesis; benign prostatic hyperplasia; medicinal chemistry

Project: Total synthesis and medicinal chemistry: natural phloroglucinolic compounds with potent antimicrobial properties
Antimicrobial drug discovery is continually in high demand due to rising antimicrobial-

resistant microbial pathogens. In the past decade, considerable attention has been paid to phloroglucinols of natural origin due to their biological functions, especially their potent antimicrobial activity. Callistemonols A and B are two unusual phloroglucinol derivatives isolated from Callistemon viminalis leaf extract. These unique compounds, characterised by an α,β-triketone-fused phloroglucinolic structure and an acylphloroglucinol derivative, respectively, have demonstrated remarkable and rapid inhibitory activity against methicillin-resistant S. aureus (MRSA) at minimum bactericidal concentration and minimum inhibitory concentration values that were 2−4 fold lower than those of vancomycin (i.e., 1.56−6.25 μg/mL). This project endeavours to accomplish the total synthesis of these complex and highly bioactive molecules, with a long-term vision of revealing their potential in medicinal chemistry through structure-activity studies. Students with an interest in organic synthesis and medicinal chemistry are encouraged to apply.

Contact:
Distinguished Professor Margaret Brimble (m.brimble@auckland.ac.nz)
Dr Freda Li (freda.li@auckland.ac.nz)
Keywords: asymmetric synthesis; methodology development; phloroglucinol derivatives; antimicrobial activity

- ***School of Computer Science***

Project: Mathematical and algorithmic challenges in phylogenetics
How did HIV evolve? Which vaccine will best protect against next season's flu? To answer these and other questions in the study of evolution, phylogenetic trees and networks play a crucial role. Phylogenetic networks are leaf-labelled rooted acyclic digraphs that are used to represent the evolutionary history of a set of present-day species. To accurately reconstruct phylogenetic networks, a deep understanding of their underlying mathematical structure is necessary. The goal of this project is to develop new theory and algorithms to unravel complex ancestral relationships between species without compromising accuracy. Of particular interest is the development of new parameterized and approximation algorithms to tackle some unanswered questions in the reconstruction and comparison of phylogenetic networks. Candidates are expected to have a strong background in graph theory or theoretical computer science.
Contact: Associate Professor Simone Linz (s.linz@auckland.ac.nz)
Keywords: algorithms; graph theory; computational biology; evolution

Project: Applications of quantum annealing in computational biology
Phylogenetic (evolutionary) trees are widely used by biologists to represent ancestral relationships between species. Due to non-treelike events such as hybridization and horizontal gene transfer that cannot be captured by a single phylogenetic tree, the representation of evolution is now being generalized to phylogenetic networks which are leaf-labelled directed acyclic graphs. However, in contrast to algorithms for phylogenetic trees, many of the algorithms that are currently being used to reconstruct and analyse phylogenetic networks do not scale up well to large data sets. The purpose of this project is to develop new algorithms to reconstruct phylogenetic networks by using quantum annealing (implemented by the Advantage D-Wave machine). This model of quantum computing can solve native optimization problems and is well suited for this project. The project combines the development of the model, the proof of correctness and experimental testing on Advantage D-Wave. Candidates are expected to have a strong

background in discrete mathematics and/or theoretical computer science. Knowledge in biology is not required.

Contact:

Professor Cristian S. Calude (cristian@cs.auckland.ac.nz)
Dr Michael J. Dinneen (mjd@cs.auckland.ac.nz)
Associate Professor Simone Linz (s.linz@auckland.ac.nz)

Keywords: quantum computing; bioinformatics; graph theory; phylogenetics

Project: Machine learning assessment of motion sickness levels in metaverse

Despite the increasing popularity of VR games, one factor hindering the industry's rapid growth is motion sickness experienced by the users. Symptoms such as fatigue and nausea severely hamper the user experience. Recently, researchers have used machine learning approaches to identify motion sickness in VR experience. These approaches demand an accurately labelled, real-world, and diverse dataset for high accuracy and generalizability. To our knowledge, such a comprehensive dataset does not exist. To address this need, we aim to curate a dataset called VR.net, which offers 1000-hour gameplay videos from 100 real-world games in 10 diverse genres. For each video frame, a rich set of motion sickness-related labels, such as camera/object movement, depth field, and motion flow, are accurately assigned. Building such a dataset is challenging since manual labelling would require an infeasible amount of time. Instead, we are building an in-house tool to extract ground truth data automatically and precisely from 3D engines' rendering pipelines without accessing VR games' source code. This is achieved by exploiting a series of software engineering techniques such as reverse engineering and dynamic hooking. We believe that the scale, accuracy, and diversity of VR.net can offer unparalleled opportunities for VR motion sickness research and beyond.

Contact: Dr Elliott Wen (elliott.wen@auckland.ac.nz)

Keywords: metaverse; VR/AR; human computer interaction; machine learning; software engineering

Project: Investigation of computational architecture for Edge AI

Edge Artificial Intelligence is a system that uses Machine Learning algorithms to process data generated by a hardware device without a connection to the internet. A complete processing toolkit that allows on-device inference is highly desirable. It allows us to build products that are efficient, private, fast, and offline. Computer Architecture for Edge Artificial Intelligence has become a popular research topic.

In this project, we explore the research on quantization for edge AI. It is an active area of research aimed at reducing the computational and memory requirements of artificial intelligence (AI) models to make them suitable for deployment on edge devices with limited resources. Various quantization techniques have been proposed to reduce the precision (number of bits) required to represent the weights and activations of neural networks. This includes fixed-point quantization, where floating-point values are approximated with fixed-point representations, and binary quantization, where weights and activations are constrained to binary values (-1 and 1). The research objective is to find the most appropriate quantization techniques to give the best trade-off between accuracy and computation complexity.

Contact: Dr Chiu-Wing Sham (b.sham@auckland.ac.nz)

Keywords: computer architecture; machine learning

Project: Accelerating chip design with machine learning
Chip floorplanning plays an important role in the physical design of very large-scale integrated circuits. It plans the shapes and locations of the modules on a chip. It generates the physical layout of a computer chip, the result of which will greatly affect the overall performance of the final circuit. Chip floorplanning is a very time-consuming task (up to a few months) to produce manufacturable layouts.
In this project, the student is going devise a reinforcement learning model to carry out the chip floorplanning process including place-and-route, timing, and physical signoff analysis. The proposed method should be able to be used to design the next generation of artificial intelligence (AI) accelerators. More powerful AI-designed hardware will fuel advances in AI. This creates a symbiotic relationship between the two fields.
Contact: Dr Chiu-Wing Sham (b.sham@auckland.ac.nz)
Keywords: design automation; VLSI

Project: Accelerating the process of spatial computation for housing characteristics
The study of housing characteristics is used to compute the proportion of house cohorts within a certain distance/neighbourhood. This study exploits the proportion of a particular cohort of houses to the total number of houses within walking distance (both 0.5km and 1.0km) to proxy the "urban ambience" effects. Two steps are involved in coming up with the proportion of a particular cohort of houses for every property in Auckland, namely 1) creating an N×N distance matrix for all properties in Auckland; and 2) performing the conditional spatial counting based on building cohort (i.e., counting the number of buildings of a particular cohort to the total within a prescribed radius). Since there is a large volume of houses in the study, typical methods may not be good enough to be used for this purpose. In this project, we are going to apply a novel data structure to store the data and a more innovative algorithm such as Delaunay triangulation to perform computation.
Contact: Dr Chiu-Wing Sham (b.sham@auckland.ac.nz)
Keywords: spatial analysis

Project: The economics value of pedestrianisation and place-making: evidence from touristification impacts on high street retail
This proposal is a transdisciplinary research project that incorporates computer science, tourism, property studies, and urban studies. In the literature, pedestrianisation and place-making are known to create economically competitive and liveable urban areas. This study uses the COVID-19 period as a quasi-experiment to examine the economic value of pedestrianisation and touristification in high street retail. Given New Zealand's borders reopened to all tourists in the second half of 2022, this project aims to investigate the association between pedestrianisation of shopping street, tourists' footfall, retail sales and tenant mix changes. The methodology involves applications of computer science knowledge in integrating human mobility data and property market data. The study will develop an evidence-based framework to inform local governments and destination management organisations worldwide of the recovery plan for tourism after the pandemic.
Contact: Dr Chiu-Wing Sham (b.sham@auckland.ac.nz)
Keywords: computer science on tourism; property studies; urban studies

Project: Narrowing the gap between calculations and experiments in the electrochemical CO2 reduction reaction

Rational catalyst design is arguably the ultimate goal in heterogeneous catalysis research. In the last few decades, new computational methods have been developed to further our understanding of the catalytic performance of heterogeneous catalysts, which makes it possible to do a priori catalyst design using high-performance computing resources. However, there is still a large disagreement between theoretical prediction and experimental performance to truly revolutionise the chemical industry. The disagreement is mainly caused by the differences between the predicted catalyst structures from computational chemistry and the synthesised catalyst in the actual experiment. Understanding these false-positive predictions by collaborating with experiment scientist is necessary to refine the current computational chemistry framework and improveprediction accuracy.

In this project, the student will learn how to develop a high-throughput catalyst design method using descriptor-based design framework and machine learning algorithm. The adsorption energy of intermediate states will be used as the descriptor, and the catalyst structure with the optimal adsorption energy will be chosen as potential candidates for experimental screening, carried out by the experiment collaborators. The student will analyse the catalytic performance and theoretical calculation to deduce any structure-to-properties relationship. Further iterations will be performed to design a final catalyst with superior performance. The CO2 electrochemical reduction reaction (CO2RR) will be used as a model reaction in this project due to its significant technological importance.

Contact: Dr Ziyun Wang (ziyun.wang@auckland.ac.nz)

Keywords: climate change; carbon dioxide; renewable energy; electrochemistry; computational chemistry

Project: Modelling causal behaviour using inverse reinforcement learning

Humans and animals respond to external and internal environments respectively to reach specific objectives. This results in causal behaviour that amounts to a sequence of decisions where the previous ones influence the upcoming ones. Understanding this influence can help us predict the behaviour of humans or animals as a function of certain environmental factors. This project aims to utilise machine learning techniques, particularly inverse reinforcement learning, to model the causal behaviour of humans and animals. Inverse reinforcement learning provides a framework for building a utility-based function to recover the dependencies between events coming in a sequence, holding the belief that each succeeding event is conditioned on past events and maximises future utilities. By choosing this project, you will work with the team in the Strong AI Lab. The Strong AI Lab is one of the leading research groups that aims to promote AI in various fields, including but not limited to natural language processing, social goods, ethical robotics, and industrial manufacturing. The Strong AI Lab already has an accumulation of experience and knowledge in modelling casual behaviour, reflected by the datasets [1] and papers [2,3] published on top-ranked AI venues. By participating in this project, you can publish your research work in internationally prestigious AI venues and have the potential to make your research outcome a product or an open-source tool.

[1] Meerkat Behaviour Recognition Dataset.
Mitchell Rogers, Ga ¨el Gendron, David Soriano Valdez, Mihailo Azhar, Yang Chen, Shahrokh Heidari, Caleb Perelini, Padriac O'leary, Kobe Knowles, Izak Tait, Simon Eyre, Michael Wit- brock, Patrice Delmas. 3rd Workshop on CV4Animals: Computer Vision for Animal Behavior Tracking and Modeling (in conjunction with CVPR 2023).

[2] Adversarial Inverse Reinforcement Learning for Mean Field Games
Yang Chen, Libo Zhang, Jiamou Liu, Michael Witbrock. The 22nd International Conference on Autonomous Agents and Multi-agent Systems. AAMAS 2023.
[3] Individual-Level Inverse Reinforcement Learning for Mean Field Games
Yang Chen, Libo Zhang, Jiamou Liu, Shuyue Hu. The 21st International Conference on Autonomous Agents and Multi-agent Systems. AAMAS 2022.
Contact: Professor Michael Witbrock (m.witbrok@auckland.ac.nz)
Keywords: causality discovery; inverse reinforcement learning; behaviour modelling

Project: Optimising the decoding of autoregressive language models for different downstream tasks

Decoding is a crucial but often neglected process when generating texts using pretrained Large Language Models (LLMs). An LLM outputs a distribution of probabilities over its vocabulary conditioned on the current input. A decoding algorithm determines the search and sampling strategies at each text generation step, and the metric used to select the best output if multiple candidates are generated. Different decoding algorithms can lead to very different behaviours and performance. Despite its importance, decoding is an underexplored component in LLMs for complex downstream tasks. Different tasks likely require different decoding strategies. For instance, comedians often write the punchline of a joke before figuring out the setup for the punchline. Scientific papers are rarely written word-by-word sequentially and continually from the beginning till the end. Writing non-trivial code requires composition of smaller functions and classes, which cannot easily be done in a linear and sequential fashion. Answering difficult logical reasoning questions with reasoning steps also requires more sophisticated searching strategies and value functions to evaluate each state. This research considers a pretrained LLM as a function or a tool that computes conditional probabilities given an input and investigates optimising the decoding processes for different downstream tasks.
Contact: Professor Michael Witbrock (m.witbrok@auckland.ac.nz)
Keywords: large language models; decoding; logical reasoning; pretraining

Project: Multi-modal large language models: composition of vision encoders and language model decoders for enhanced understanding

The combination of vision and language holds immense potential in various domains, including image captioning, visual question answering, and visual storytelling. While significant progress has been made in computer vision and natural language processing (NLP) independently, there is an opportunity to unlock further advancements by integrating vision encoders and large language model decoders. This research proposal outlines a study that aims to explore the composition of vision encoders and language model decoders within a multi-modal framework, enabling enhanced understanding and generation of textual content based on visual inputs.

Data collection plays a crucial role in this research, involving the assembly of a diverse and representative dataset containing paired visual and textual information. The collected dataset will be pre-processed to ensure compatibility and alignment between the visual and textual representations. The subsequent step involves training the multi-modal model using the collected dataset. The model will be trained using appropriate optimization techniques and loss functions to encourage alignment and coherence between the visual and textual representations. Strategies such as fine-tuning and cross-modal attention mechanisms will be explored to enhance performance.

This research proposal aims to explore the composition of vision encoders and language model decoders within a multi-modal framework. By integrating these components, the

proposed model aims to enhance our understanding of visual content and generate coherent textual descriptions. The outcomes of this research project will contribute to advancements in computer vision, NLP, and multi-modal learning, with potential applications in image captioning, visual question answering, and beyond.
Contact: Professor Michael Witbrock (m.witbrok@auckland.ac.nz)
Keywords: multi-modality; large language models; understanding enhancement

Project: Compositional learning with modular deep learning
A challenging problem of AI is generalising out of distribution, which usually leads to the inability to learn complex knowledge, such as logical and causal reasoning. A promising approach is compositional learning with modularity that can alleviate this issue and make them immune from low-level adversarial distribution. Modularity means to decompose a complex system into specialised components, where each component is responsible for smaller building blocks. Learning will be efficient and robustly scalable as it will focus on the relevant components with fewer parameters. The student will develop automatically-learned modularity for deep learning models that can compositionally scale to represent high-level knowledge. In addition to improving generalisation, this research is expected to encourage the potential of interpretability. The benefits of modular deep learning can be demonstrated by interpreting AI models. This research will contribute to both the scalability and the safety of AI.
Contact: Professor Michael Witbrock (m.witbrok@auckland.ac.nz)
Keywords: large languages; compositional learning; modularity; interpretability

Project: A gamified virtual reality tutor for training spatial reasoning skills
Spatial skills are a significant predictor of achievement in STEM subjects (Science, Technology, Engineering, and Mathematics). In contrast to many other cognitive abilities, spatial skills can be trained. However, it is unclear how to make training effective and enjoyable for a wide range of users. In this research, we will develop and evaluate a VR training tool for spatial skills, which will be based on recent research in pedagogy and neuroscience. In order to make the application engaging, it will contain gamification elements.
Contact: Dr Burkhard Wuensche (burkhard@cs.auckland.ac.nz)
Keywords: VR; spatial reasoning; education

Project: Automatic generation of formative feedback for computer graphics programming assignments
Teaching and learning computer graphics is often considered challenging as it requires a diverse range of skills such as mathematics, programming, problem solving, and art and design. Assignments are a popular tool to support learning and to assess students' understanding. The value of such assignments depends on the ability to give fast (and ideally formative) feedback, enabling students to interactively explore the solution space. This is often a problem, in particular for large classes, where assignment marking can take many days or even weeks. By the time feedback is received students often don't remember details, and there is usually no opportunity to resubmit and hence little motivation to reflect on and correct mistakes.
In previous research we developed CodeRunnerGL, a tool for automatic assessment of OpenGL programming questions. The tool has been used in a class of about 300 students for several years and students perceive the tool as having significantly improved their learning.

In the proposed research we will extend CodeRunnerGL to automatically produce formative feedback. This means, if a student solution is incorrect the tool should provide feedback as to where the error is, and it should give hints as to how the error could be resolved (without displaying the correct solution).
Contact: Dr Burkhard Wuensche (burkhard@cs.auckland.ac.nz)
Keywords: educational assessment; formative feedback

Project: AR/VR embodied spatial training
Spatial skills are a significant predictor of achievement in STEM subjects (Science, Technology, Engineering, and Mathematics). In contrast to many other cognitive abilities, spatial skills can be trained. In this project we will investigate how spatial reasoning skills can be trained in AR/VR by physically interacting with virtual or augmented objects, and whether training effects are improved when using physical motions (e.g., hand gestures) rather than mouse interactions. In addition, we also want to investigate the role of haptic feedback on spatial training in an AV/AR environment.
Contact: Dr Burkhard Wuensche (burkhard@cs.auckland.ac.nz)
Keywords: VR; spatial reasoning; education

Project: Procedural generation of multi-version questions for computer graphics programming assessments
Assessment is an important part of teaching and learning. For practical computer science courses, programming questions are preferred as an assessment method. Programming assignments that require the use of computers and internet access are often hard to control. This makes it easy to cheat, e.g. searching the web for solutions, using tools such as Chegg, and by using social media to discuss and exchange solutions with peers. The use of multi-version questions is an effective way to detect and reduce the risk of cheating since any two students are unlikely to have the same set of questions.
In this project we will develop a program for procedurally generating programming questions for computer graphics assessments. The tool should enable instructors to set certain parameters for a question and from this automatically generate a set of questions including sample solution, output images, and test cases. The information should be stored in an HTML file. The project will use CodeRunner and if possible, the generated HTML files should get imported into the CodeRunner question bank.
Contact: Dr Burkhard Wuensche (burkhard@cs.auckland.ac.nz)
Keywords: educational assessment

- ***School of Environment and School of Chemical Sciences***

Project: Risk assessment of nanopesticides
A variety of nano-delivery systems for pesticides, called nanopesticides, are being proposed and evaluated to improve current agricultural practices. Such delivery systems can be made of a range of materials, including inorganic (e.g., metals, metal oxides, clays), organic (e.g., polymers, lipids), and biological materials (e.g., inactive viruses). The potential applications and benefits are likely to be enormous. However, agroecosystems are incredibly diverse and complex, and designing viable and safe products for application in the field is challenging. This project looks at the fate and effects of a series of nanopesticides relative to currently used products. Laboratory experiments will be conducted across a range of conditions relevant for ecological and/or

human health risk assessment. The results will guide the design of more sustainable nanopesticides and help regulators in assessing the potential risk associated.
Contact: Associate Professor Melanie Kah (melanie.kah@auckland.ac.nz)
Keywords: pesticide; nanoparticle; fate; ecotoxicity; advanced materials; soil; water

Project: Fate of soluble polymers in the environment
Water-soluble polymers are used in a wide array of applications that result in their release into the environment. For instance, water-soluble polymers are increasingly used as co-formulants for pesticide formulations that are applied in agriculture. The environmental fate of water-soluble polymers is mostly unknown, which makes their risk assessment highly uncertain. An important challenge is that polymers are difficult to detect in the environment and standard experimental approaches are often unsuitable. This project will address these knowledge gaps by (1) developing novel and suitable approaches, and (2) generating experimental data on the environmental fate of a series of soluble polymers in soil and in water. The knowledge generated will be essential (1) to assess the risk that soluble polymers currently pose to the environment and (2) to suggest more sustainable alternatives.
Contact: Associate Professor Melanie Kah (melanie.kah@auckland.ac.nz)
Keywords: environment; risk; fate; plastic; soil; water

Project: Environmental fate and remediation of PFAS
Perfluoroalkyl and Polyfluoroalkyl Substances (PFAS) are a group of >9,000 exceptional chemicals. They are now well recognised global contaminants due to their toxicity and stability (PFAS are also known as "forever chemicals"). The most common approach for treating PFAS contaminated water currently relies on sorption to engineered sorbents. What to do with the spent sorbent is a controversial question as current practices (e.g., incineration and disposal into landfill) are associated with risks in the longer term. Our analysis of the recent literature has identified several knowledge-gaps that should be urgently addressed to design sustainable remediation solutions, including an improved management of spent sorbent materials. This project will address some of these gaps with experiments conducted at the laboratory and pilot scale.
Contact: Associate Professor Melanie Kah (melanie.kah@auckland.ac.nz)
Keywords: PFAS; sorption; remediation; soil; water

- ***Department of Mathematics***

Project: Making sense of the complexity of university-level mathematics education and bettering its teaching and learning
University courses in mathematics have a reputation for being intense and difficult for many students. Large classes, dense curricula, mathematical content that is conveyed in a way that is substantially different from the one that students are familiar with from high school – these and many other factors contribute to the complexity of students' learning of mathematics. This is a large-scale project with multiple components aiming to understand the complexity of the process's students go through when studying university-level mathematics and explore the impact of innovative learning-and-teaching environments on these processes. PhD students who join this project might be interested in exploring teaching and learning processes that unfold in undergraduate courses in analysis, abstract algebra, combinatorics, graph theory, game theory, number theory, or

topology, possibly with a focus on how undergraduates work with definitions, generate examples, prove, solve, and pose problems.
Contact: Dr Igor' Kontorovich (i.kontorovich@auckland.ac.nz)
Keywords: mathematics education; university mathematics; school mathematics; teacher preparation; teaching and learning

Project: School and university mathematics education: students' usage of online forums for mathematics learning
On the one hand, there is evidence of a decline in students' interest in mathematics. On the other hand, there are many posts in online mathematical forums with rich and insightful discussions contributed by school and university students. Some of these discussions are tightly linked to homework assignments that students get in a classroom. Other discussions reflect students' genuine interests in mathematics and a desire to make sense of it. Surprisingly, the widespread phenomenon of student (and teachers') usage of open online mathematical forums has not been explored yet.
PhD students who join this project might be interested to explore the topics that are discussed in open online mathematical forums while attending to their communicational patterns. It is also important to understand how students make use of such forums in respect to their school and university studies, and how teachers should account for these usages in their teaching, for instance, when designing homework assignments.
Contact: Dr Igor' Kontorovich (i.kontorovich@auckland.ac.nz)
Keywords: mathematics education; university mathematics; school mathematics; teacher preparation; teaching and learning

Project: Mathematical physiology and dynamical systems
Oscillations and waves in the concentration of free cytosolic calcium are one of the most important intracellular signalling mechanisms, controlling a wide range of cellular functions, including gene expression, cell differentiation, secretion, and water transport. However, although they are physiologically important, these periodic phenomena are difficult to study using experimental techniques alone; their complexity is so great that only limited understanding can be gained in the absence of quantitative approaches. Thus, over the past few decades the study of calcium dynamics has developed into an important area of interdisciplinary research.
In collaboration with major international experimental groups in the USA, Japan and Europe, our research group is interested in constructing new mathematical models for calcium oscillations. These models allow us to make predictions that inform and guide further experiments, ultimately leading to a better understanding of the underlying physiology. Members of our research group also work on developing new mathematical ideas useful for the analysis of a wide class of physical and biological models, including our calcium models.
We welcome queries from students with a strong background in mathematics and an interest in cell physiology, although no prior background in physiology is required.
Contact:
Professor James Sneyd (j.sneyd@auckland.ac.nz)
Professor Vivien Kirk (v.kirk@auckland.ac.nz)
Keywords: mathematical biology; dynamical systems; calcium dynamics; physiology

Project: Topological analysis of complex patterns formed during soft matter crystallisation
Soft matter such as polymers and liquid crystals can crystallise into diverse arrangements from regular crystals to completely disordered glassy states. Recent advances in modelling allow us to obtain, both in 2D/3D, a large variety of complex spatial patterns that can have different symmetries or presence/absence of defects. If we can visualise the geometry of the state space in these models, then we can use methods from the analysis of lower dimensional systems to nudge an evolution towards a preferred state. Visualising the state space requires quantitative differentiation of the observed complex spatial patterns states via a measure. This PhD project proposes to develop topological measures that are superior to the current state-of-the-art spectral measures. The main goal will be to promote the use of topological measures to characterise complex spatial patterns arising during soft matter crystallisation. Exposure to numerical simulations of PDEs/nonlinear dynamics/pattern formation is desirable but not necessary.
Contact: Dr Priya Subramanian (priya.subramanian@auckland.ac.nz)
Keywords: pattern formation; soft matter; quasicrystals

- ***Institute of Marine Science***

Optimizing nursery culture of mussel spat
The early stages of mussel aquaculture can be extremely inefficient, with the majority of seed mussels, or 'spat', often lost from farms within the first few months of production. One solution to these high spat losses is to grow spat to larger sizes in nursery systems. However, there is considerable work to be done to begin to optimize current nursery culture practices. This project will investigate the impact of flow rate on the feeding behaviour of Greenshell mussel spat of a range of sizes with the goal of identifying flow rates that optimize feeding behaviour in this species.
Contact:
Dr Brad Skelton (brad.skelton@auckland.ac.nz)
Professor Andrew Jeffs (a.jeffs@auckland.ac.nz)
Keywords: Mussel aquaculture; shellfish; flow rates; aquaculture

- ***Department of Physics***

PhD opportunities in nonlinear photonics
We are looking for motivated PhD students to join our nonlinear photonics group at the University of Auckland. Our investigators have extensive research experience in disciplines ranging from optical telecommunications to supercontinuum generation and mode-locked fibre lasers. Our current research interests revolve around the physics and applications of coherently driven nonlinear resonators, such as macroscopic fibre ring resonators and whispering-gallery-mode microresonators. We seek to advance the understanding of the nonlinear optical phenomena that manifest themselves in such devices and explore pathways to harness those phenomena for practical applications. More detailed information is available from our website, or please contact us directly.

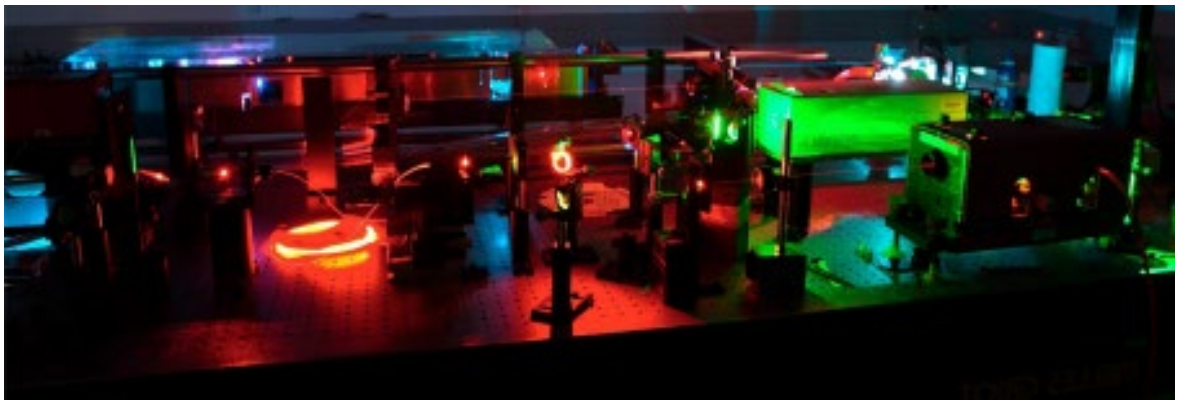
Project: Microresonator frequency combs
Optical frequency combs are laser light sources whose spectrum is composed of

numerous equidistant lines. They have had a transformative impact in the field of spectroscopy, enabling experimental measurements with astonishing precision. In 2007, a remarkable new method of frequency comb generation was demonstrated: low-power continuous wave laser light could spontaneously transform into a broadband frequency comb when coupled into an ultra-high-quality microresonator. Because of their unique characteristics, such "microresonator frequency combs" have potential to revolutionize several applications ranging from telecommunications to ranging, and they have accordingly attracted considerable research interest over the last decade.

Project: Widely tunable Kerr parametric oscillators
The ability to generate laser light that can be continuously tuned over wide regions of the electromagnetic spectrum is highly desirable. An attractive solution is to utilize nonlinear optical interactions to convert a monochromatic laser beam to other wavelengths that can be widely tuned via small adjustments of the input wavelength. Because suitable nonlinear interactions can be observed at very low input power levels in carefully designed whispering-gallery-mode microresonators, such devices could enable the realization of low-cost and compact sources of widely-tunable laser light. In our research, we investigate the generation of widely-tunable parametric sidebands in Kerr microresonators, with particular focus on realizing devices that can convert near-infrared laser light into tunable light in the mid-infrared spectral region.

Project: Nonlinear dynamics in optical fibre ring resonators
Coherently driven optical fibre ring resonators display a wealth of universal dynamics associated with nonlinear systems driven out of equilibrium: pattern formation, dissipative solitons (known as temporal cavity solitons), switching waves, domain walls etc. Moreover, fibre resonators are analogous to Kerr microresonators that have attracted attention in the context of optical frequency comb generation. As a consequence, fibre resonators can be used as convenient testbeds to explore nonlinear phenomena whose direct study may not be straightforward in microresonators due to their small size.

Contact:
Associate Professor Stuart Murdoch (s.murdoch@auckland.ac.nz)
Dr Miro Erkintalo (m.erkintalo@auckland.ac.nz)
Associate Professor Stephane Coen (s.coen@auckland.ac.nz)
www.laserlab.auckland.ac.nz
Keywords: laser physics; nonlinear optics; optical frequency combs; microresonators; optical solitons



- ***School of Psychology***

Project: Investigating vocabulary development in Chinese - English bilingual children in New Zealand
Research indicates that the number and type of words bilingual children have in their two languages differ to that of their monolingual peers in either language. Little research has been undertaken to investigate this question with the pairing of Chinese (Putonghua) and English-speaking children. This study will be the first of its kind in investigating bilingual children's knowledge of words in Chinese and English. The study will investigate this question with either preschool (3-5 years) or early primary school (5-6 years) children.
Contact: Dr Elaine Ballard (e.ballard@auckland.ac.nz)
Keywords: Chinese; bilingualism; linguistic analysis

Project: Investigating any aspect of grammatical development in Chinese - English bilingual children in NZ
There is very little research into the syntactic development of Chinese and English in bilingual children. This will be a landmark study investigating an aspect of grammatical structure (e.g., tense/aspect marking, pronouns) in children's language development in their two languages. The study will investigate this question with either preschool (3-5 years) or early primary school (5-6 years) children.
Contact: Dr Elaine Ballard (e.ballard@auckland.ac.nz)
Keywords: Chinese; bilingualism; linguistic analysis

Project: Performance of Chinese (Putonghua and/or any other varieties of Chinese) speaking adults on the Chinese and English versions of the Boston Naming Test
The Boston Naming Test is a picture naming assessment used to diagnose language impairment. The test has been translated into both Cantonese and Mandarin, but it has not been tested out extensively on healthy Chinese speaking populations resident in a Western country. This study will gather data from adult speakers so that the test can be standardised for Chinese populations resident in New Zealand. Students will gather data from either Chinese variety or both varieties.
Contact: Dr Elaine Ballard (e.ballard@auckland.ac.nz)
Keywords: Chinese; bilingualism; linguistic analysis

Project: Chinese language acquisition in second language learners
With China now a global power, many New Zealanders have become interested in learning Mandarin. However, they may struggle with aspects of the language (tones, consonants, specific grammatical structures). In this study one aspect of Chinese that is problematic to second language learners of the language will be investigated.
Contact: Dr Elaine Ballard (e.ballard@auckland.ac.nz)
Keywords: Chinese; bilingualism; linguistic analysis

- ***Department of Statistics***

Project: Properties of the one standard error rule
The 1-SE rule is a widely-used heuristic modification to help avoid overfitting based on applying a classifier to test data. It is a very popular method in data science and machine learning. However, its properties have received little to no theoretical attention. The aim of this work is to derive the theoretical properties of the 1-SE rule. As well as obtaining its asymptotic properties, we wish to propose practical guidelines to make best use of the rule.
Contact: Dr Thomas Yee (t.yee@auckland.ac.nz)
Keywords: sequential analysis; multiple testing; statistical power; cross validation; model selection; hypothesis testing; asymptotic theory

Project: Vector generalized linear mixed models
The class of generalized linear mixed models (GLMMs) follows by adding random effects to GLMs, and they are very widely used. The aim of this research topic is to add random effects to the class of VGLMs, which is very large. Thus random effects capabilities could be added to many statistical models simultaneously. Several possible estimation algorithms to be considered include joint maximization methods such as Schall (1991, Biometrika) and quasi-likelihood estimators, Monte Carlo variants of the Newton-Raphson and EM algorithms, restricted maximum likelihood, the Laplace approximation, and adaptive Gaussian quadrature. To fully develop new algorithms for VGLMMs it is expected that the function vglmm() be written and added to the VGAM R package.
Contact: Dr Thomas Yee (t.yee@auckland.ac.nz)
Keywords: random effects models; numerical quadrature; longitudinal data; BLUP; penalized quasi-likelihood; iteratively reweighted least squares; laplace approximation

Project: Topics in information geometry
Information geometry, based on differential geometry in pure mathematics, offers deep insights into certain areas of statistics. It provides a parameterization-independent approach to statistical estimation of parametric models that operates on flat or curved manifolds. This project will explore parameter space dynamics of distributions based on differential geometrical ideas, e.g., tangent spaces, statistical curvature, tensors, and asymptotic theory. It would suit a student with a strong background in calculus/analysis and mathematical statistics. The background to this topic includes the work of Amari, Barndorff-Nielsen and Cox, and Efron, amongst many others.
Contact: Dr Thomas Yee (t.yee@auckland.ac.nz)
Keywords: riemannian manifolds; expected (Fisher) information matrix; convex analysis; exponential families; divergence (e.g., Bregman and Kullback-Leibler); connections

Project: A novel Bayesian approach to study the effect of unreliable data. (What do you do when the data is unreliable?)
Today we live in the age of data; critical decisions are often made based on the insights generated from modelling the data. However, uncertainty in the data can pose challenges in several important ways. For example, crimes such as family violence are notoriously under-reported, data on past extreme/rare events may not be available because they haven't happened recently (but could happen tomorrow), many species may not be observed accurately because of the nature of the habitat, an adversary could corrupt your data in a cyber-attack, etc. We have developed a novel method to quantify

uncertainty in the Bayesian inference due to unreliable data. In this project you will work on this cutting-edge method to develop solutions for a real-life application. This is a mathematical and computational project.
Contact: Dr Chaitanya Joshi (chaitanya.joshi@auckland.ac.nz)
Keywords: Bayesian robustness; classes of prior distributions; MCMC methods; uncertainty in data.

Project: Using Bayesian deep learning to quantify a decision-maker's uncertainty
Bayesian deep learning can be used to understand the uncertainty in the predictions made by a deep learning algorithm. Our recent research, however, has shown that Bayesian deep learning can also be used to quantify the aleatory and epistemic uncertainties as perceived by an expert decision-maker. This project will firstly investigate how this concept could be applied to a real-life complex decision-making task to quantify the expert uncertainty. Next, the project will investigate ways in which this uncertainty quantification can lead to better decision-making in the future.
Contact: Dr Chaitanya Joshi (chaitanya.joshi@auckland.ac.nz)
Keywords: Bayesian deep learning; deep learning; machine learning; decision-making; quantifying expert uncertainty.

Defending against a poisoned data in a cyberattack
Data poisoning refers to a deliberate manipulation of the data. This is often relevant in cyber-security, where an intelligent strategic adversary may be able to gain access to data and poison it so as it misleads the defender. This project will investigate how adversarial risk analysis can be used to develop realistic and optimal strategies for the defender to defend against such a data poisoning attack. It will develop a general solution that will be applied to a specific real-life example.
Contact: Dr Chaitanya Joshi (chaitanya.joshi@auckland.ac.nz)
Keywords: adversarial risk analysis; cyber security; uncertainty in the data; expert utility functions

Project: Bayesian approaches to estimating the stochastic gravitational wave background
The planned ESA space-based gravitational wave detector LISA will be operating in the low-frequency regime allowing it to detect gravitational signal from the stochastic gravitational wave background (SGWB). The SGWB is the gravitational analogue to the cosmic microwave background and results from a large number of weak, independent, and unresolved sources of astrophysical and cosmological origin. An observed SGWB would provide a wealth of information about the universe. This project aims at developing novel Bayesian nonparametric methods for estimating the power spectrum of the SGWB. A good knowledge of and interest in Bayesian inference, MCMC techniques, and time series as well as good programming skills and knowledge of R/Python are essential. This project would be suitable for students of statistics and/or physics. This project will give an opportunity to be involved in an international ESA-led collaboration, see https://www.gravity.ac.nz/people/.
Contact: Professor Renate Meyer (renate.meyer@auckland.ac.nz)
Keywords: Bayesian inference; MCMC; time series analysis; spectral analysis; gravitational waves

Project: Locally stationary time series with applications to Bayesian modelling of LISA noise

This project aims to develop Bayesian parametric and nonparametric approaches to modelling the second order properties of locally stationary time series. The main objectives are to further develop and scale up existing techniques to large data sets and develop novel extensions from univariate to multivariate time series. The developed techniques will be tested and applied to simulated data expected to be observed by the future space-based gravitational wave observatory LISA.

This project could be suitable for either a statistician or a physicist with interest in data analysis and will give an opportunity to be involved in an international ESA-led collaboration, see https://www.gravity.ac.nz/people/.

Requirements: Experience with time series analysis, Bayesian statistics and/or gravitational wave data analysis. Good programming skills and knowledge of R or Python are essential.

Contact: Professor Renate Meyer (renate.meyer@auckland.ac.nz)

Keywords: non-stationary time series; Bayesian inference; MCMC; gravitational waves

Project: Variational Bayesian methods for nonparametric spectral density estimation

Nonparametric priors based on the Dirichlet process have wide applications in applied Bayesian inference and machine learning. However, Markov chain Monte Carlo techniques for sampling from the posterior distribution can be very computationally expensive and time-consuming. This project aims to investigate and develop variational inference for Dirichlet process mixtures. Variational Bayesian methods are deterministic algorithms that instead of sampling from the exact posterior distribution, optimize the parameters of an approximating distribution. The main objective is to investigate and develop variational inference for nonparametric spectral density estimation of stationary time series.

Requirements: Experience with Bayesian statistics, machine learning and sound programming skills.

Contact: Professor Renate Meyer (renate.meyer@auckland.ac.nz)

Keywords: variational inference; numerical optimization time series