UNIVERSITY OF AUCKLAND
Waipapa Taumata Rau
NEW ZEALAND

Doctoral Project Opportunities 2025

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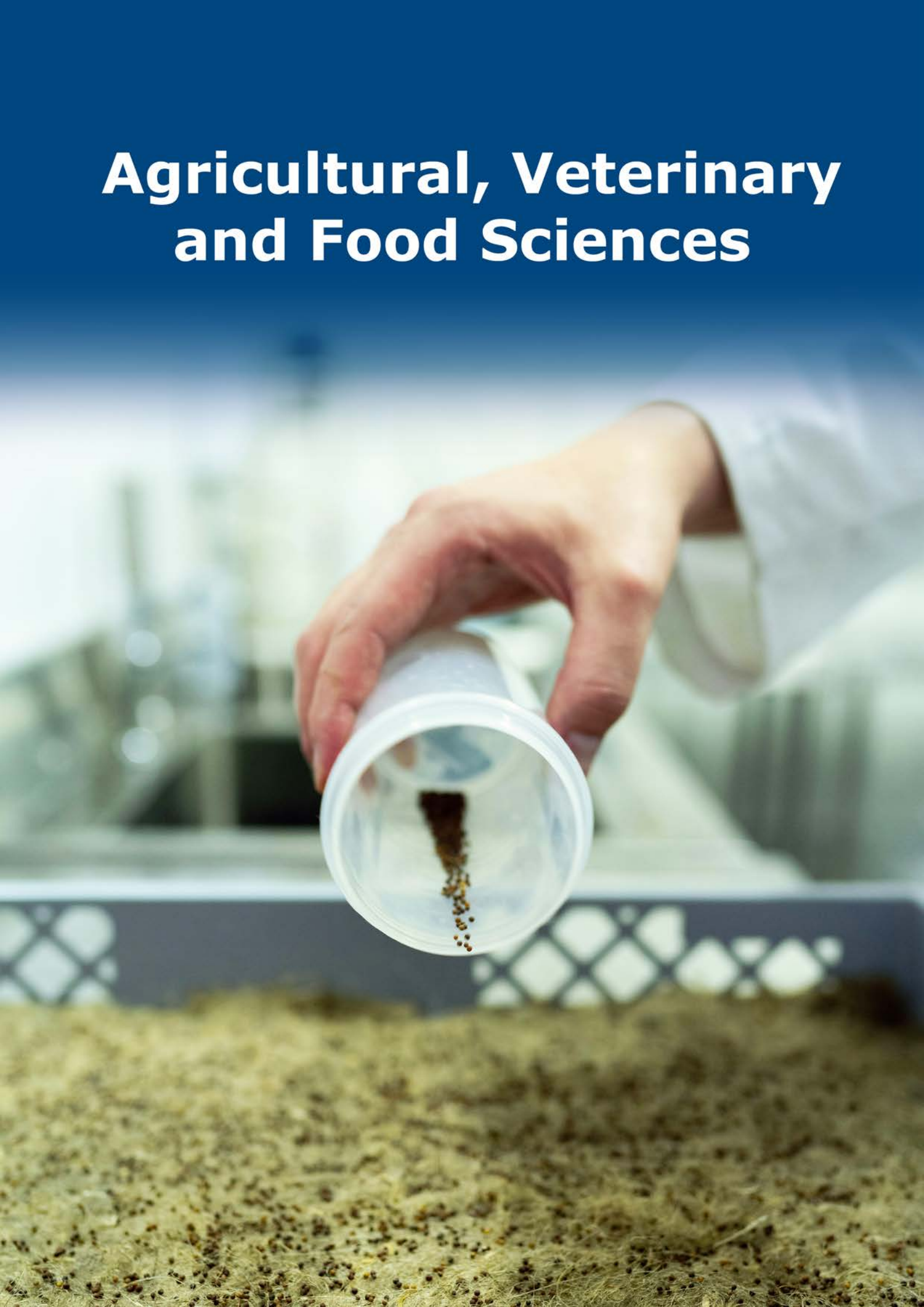
Agricultural, Veterinary and Food Sciences



Fisheries and Aquaculture

Understanding the habitat use, recruitment success and population structure of key fishery species. Optimising the husbandry, nutrition, production, seed supply and feed efficiency of cultured species in various farm environments

New Zealand has jurisdiction over the 4th largest Exclusive Economic Zone in the world and has stood at the forefront of successful fisheries management since the inception of the Quota Management System in 1986. Seafood provides valuable employment opportunities and significant export revenue for New Zealand so harvesting seafood resources with sustainable best practise and with minimal impact remains a high priority for this country. Researchers involved with fisheries research at the University of Auckland are involved in answering key questions for the sustainable harvest of our marine living resources.

Aquaculture in New Zealand has grown from small beginnings to a significant primary industry, sustainably producing the world's best seafood – Greenshell Mussels, King Salmon and Pacific Oysters. Researchers at the University of Auckland work hand-in-hand with industry to solve production problems so that the highest quality seafood products can be grown on a sustainable basis, either within land-based grow out systems (RAS) or within the clean inshore and offshore waters of New Zealand. The key culture species in our research are mussels, salmon, kingfish, oysters and scallops but the potential for new candidate species (e.g. octopus) is always being explored too.

Andrew Jeffs
Neill Herbert
Darren Parsons
Brad Skelton

Location: Leigh Marine Laboratory and aquaculture centres nationwide

Fields of research: Agricultural veterinary and food sciences; Fisheries sciences; Aquaculture; Aquaculture and fisheries stock assessments; Fish physiology and genetics; Fisheries management

Honey Quality Authentication using Hyperspectral Imaging and Deep Neural Networks

To develop a rapid and precise technique for honey quality detection using hyperspectral imaging combined with deep neural networks. We authenticate the quality of honey, safeguarding the high-quality variants from potential fraud.

Honey is valued for its taste and health benefits. The market offers a range of honey qualities, from high-priced, premium varieties to more affordable, lower-quality options. The significant price difference raises concerns about the adulteration of high-quality honey, which deceives consumers and undermines genuine producers. This research aims to develop a rapid and accurate method for honey quality detection using hyperspectral imaging combined with deep neural networks. The methodology involves capturing spectral signatures of both authentic and adulterated honey samples using hyperspectral imaging. These images are processed to extract relevant features for training neural network models. Various deep neural network architectures will be implemented and tested to find the most effective model for detecting honey quality. The model's accuracy and precision will be validated using separate honey samples not involved in training. This research is crucial for the economic impact on New Zealand's honey industry, ensuring authenticity and protecting revenue for genuine producers. It also enhances consumer trust by enabling informed choices. The ideal candidate for this PhD project should have a strong background in machine learning and deep learning, with a Master's degree focused on deep learning techniques. Our laboratory is equipped with state-of-the-art tools to support this research.

Waleed Abdulla

Fields of research: Agricultural veterinary and food sciences; Food sciences; Food safety, traceability, certification and authenticity

Ruminant Nutrition and Greenhouse Gas Emissions

We have an active research group with opportunities for students in computational and experimental bioengineering related to ruminant health, productivity and greenhouse gas mitigation.

Our research focus is anaerobic fermentation in the context of ruminant (dairy cows and sheep) nutrition and waste-to-energy applications. This work involves one or more of bioreactor development, biochemical, microbial and bioinformatic analyses, animal studies and mathematical modelling. Applicants with a background in engineering, science or mathematics are encouraged to apply.

Vinod Suresh
Mark Oliver

Fields of research: Agricultural veterinary and food sciences; Agricultural biotechnology; Animal production; Veterinary sciences; Agricultural biotechnology diagnostics (incl. biosensors); Animal nutrition; Veterinary anatomy and physiology; Engineering; Chemical engineering

Biological Sciences

The Circadian Clock and Temperature Cues Interplay in Modulating Plant Physiology

This project will investigate how temperature impacts circadian clock function and uncover molecular mechanisms of plant temperature responses in the context of climate change.

We are interested in understanding the molecular mechanisms controlling the interplay between the circadian clock and environmental signals in modulating plant physiology. The circadian clock is an internal timekeeping mechanism that helps plants anticipate environmental changes, such as day/night light and temperature cycles. It acts as a master regulator of plant physiology, controlling key processes, including gene expression, growth and photosynthesis, as well as seasonal processes like flowering.

This PhD project aims to investigate how temperature signals impact circadian clock function and uncover the molecular mechanisms of thermal responses. Climate change, particularly increasing temperatures, threatens food security. As sessile organisms, plants rely on environmental cues to time their developmental processes. Understanding how plants respond to temperature cues is crucial for developing innovative biotechnological strategies to cope with climate change.

This project will characterise circadian temperature responses and investigate how the circadian clock impacts plant growth and performance in a changing climate. You will molecularly and physiologically characterise temperature responses of legume species, a major economical crop group. You will utilize physiological approaches, including an automated system to measure leaf movement as a proxy for clock function, and molecular techniques such as CRISPR gene editing, cloning, plant transformation, RT-qPCR, and transcriptomics.

Soledad Perez-Santangelo

Fields of research: Biological sciences; Genetics; Plant biology; Genomics; Plant cell and molecular biology; Gene expression (incl. microarray and other genome-wide approaches); Plant physiology

AI-Driven Directed Evolution for Enzyme Optimization

Leverage AI-driven techniques to optimize enzyme evolution, combining computational modeling and experimental validation to enhance enzyme performance, streamline protein engineering processes, and accelerate the discovery of efficient biocatalysts.

This project aims to integrate artificial intelligence (AI) with directed evolution to create proteins with new or enhanced functions. Traditional directed evolution involves iterative cycles of mutagenesis and selection to evolve proteins with desired traits, but it can be time-consuming and resource-intensive. By utilizing AI-driven techniques, such as deep learning and reinforcement learning, this project seeks to predict beneficial mutations and guide the evolutionary process more efficiently.

The approach will involve using AI protein design algorithms, such as RFDiffusion, to design enzymes capable of specific reactions. This combination of computational modeling and experimental validation aims to significantly reduce the time and cost associated with enzyme optimization, enabling the rapid discovery of highly efficient biocatalysts. This project not only advances the field of protein engineering but also showcases the transformative potential of AI in accelerating biological research and innovation.

Olin Silander

Fields of research: Biological sciences; Bioinformatics and computational biology; Sequence analysis; Evolutionary biology; Evolutionary biology not elsewhere classified

Ecophysiology

This research focuses on the effects of anthropogenic stressors, namely sound and climate change, on the physiology of a variety of marine animals, birds, fish, and invertebrates (crustaceans and bivalves).

The research can be split into 4 broad research areas:

1. The effects of anthropogenic sound on marine animals, where a multi-disciplinary approach is used. This involves numerous experimental approaches, including physics of sound, anatomical, physiological and behavioural studies on both fish and crustaceans.
2. Using seabirds to predict climate change impacts. This involves a range of stress physiology, foraging behaviour, breeding success and pollutant (e.g. microplastics) studies.
3. Using a comparative and integrative approach to explore the behavioural consequences of impaired oxygen transport, the behavioural regulation of energetic demand on fish in response to environmental stressors and other concepts involving the interplay of fish physiology and behaviour.
4. Cellular physiological responses of various marine animals, such as fish, sea anemones, and worms, to environmental stressors. This work includes using sporting enhancement drugs on fish to increase metabolic rates.

Craig Radford
Brendon Dunphy
Neill Herbert
Anthony Hickey

Fields of research: Biological sciences; Zoology; Animal structure and function; Comparative physiology

Function of Female Song, Aggression and Plumage

Female birds express traits that likely improve competitive ability but might have unmeasured costs that vary according to species and ecology. The project will measure traits and relate to function and fitness.

Use integrative methods to measure and test the extent, function, and consequences of variation in female traits expression. Could be a single species or comparative species approach. Experience with capture, banding, nesting finding and monitoring a plus.

The Cain Lab

Kristal Cain

Project open until: 2027

Fields of research: Biological sciences; Ecology; Behavioural ecology; Zoology; Animal behaviour

Cell-Type Specific DNA Methylation and Differential Aging Across Tissues

Investigate how cell-type-specific DNA methylation patterns can be used as markers of differential aging across tissues, aiming to identify epigenetic markers that could reveal tissue-specific aging processes and potential therapeutic targets.

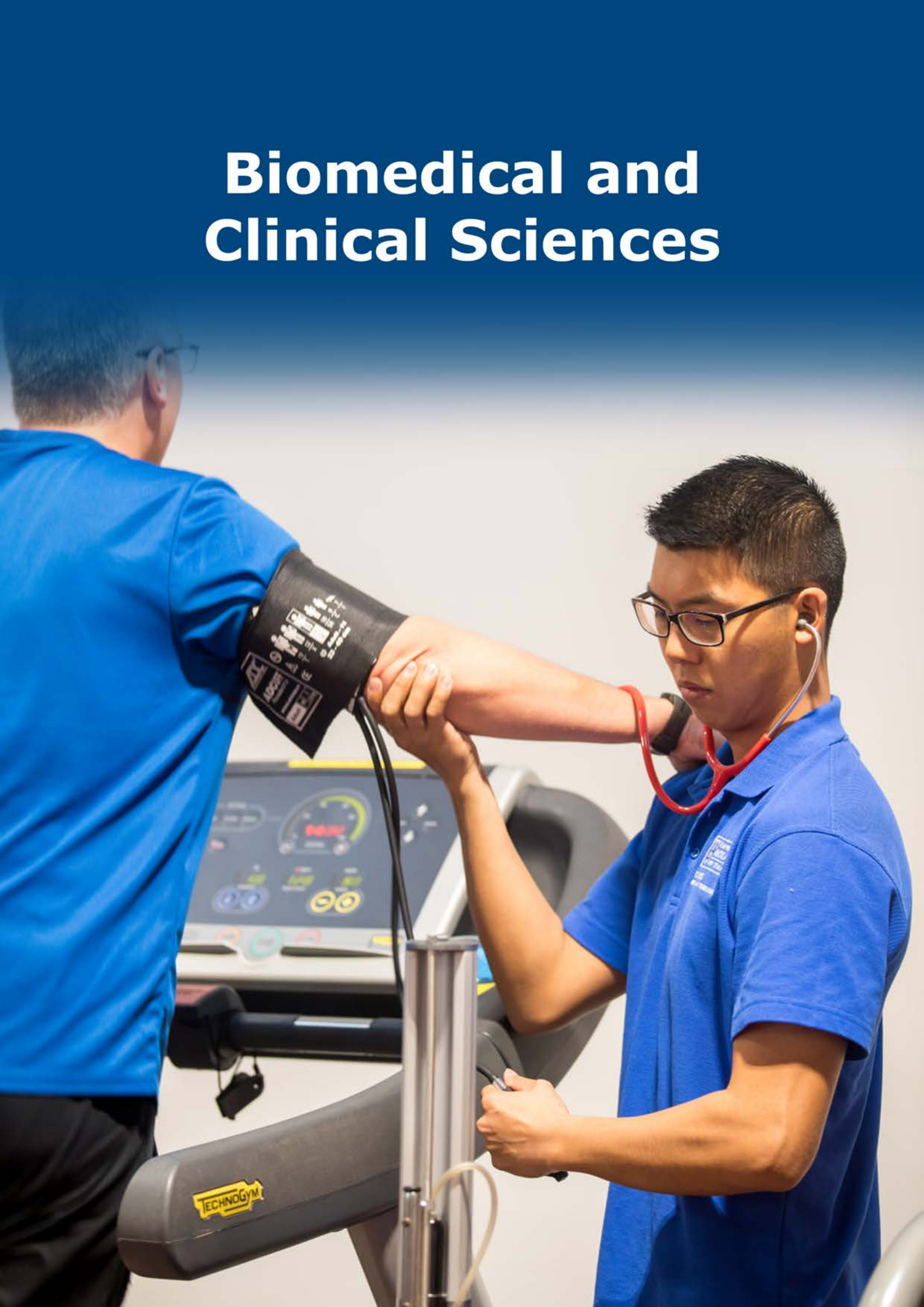
This project focuses on understanding how cell-type-specific DNA methylation pat erns might indicate different aging processes across different tissues. DNA methylation, an epigenetic modification, plays a crucial role in regulating gene expression and is known to change dynamically with age. However, these changes are not necessarily uniform across all cell types or tissues, opening the possibility that different tissues age at different rates and through distinct mechanisms. By analyzing DNA methylation pat erns at the single-molecule level, this project aims to uncover unique epigenetic signatures associated with aging in specific cell types and tissues.

The study will involve collecting and analyzing methylation data from various tissues, identifying differential methylation pat erns that correlate with aging. Advanced bioinformatics tools and machine learning algorithms will be used to dissect these pat erns and predict their impact on gene regulation and cellular function. Ultimately, the project aims to develop a comprehensive understanding of the molecular mechanisms underlying tissue-specific aging, potentially identifying new biomarkers for age-related diseases and novel therapeutic targets for interventions to slow down or reverse aging processes in specific tissues.

Olin Silander

Fields of research: Biological sciences; Biomedical and clinical sciences; Bioinformatics and computational biology; Sequence analysis; Other biomedical and clinical sciences

Biomedical and Clinical Sciences



Developing New Therapies for Diabetic Heart Disease

This project involves preclinical research into the underlying mechanisms of heart disease associated with diabetes. Novel molecular targets and their potential for therapeutic efficacy will be investigated.

This project will use rodent models of diabetes coupled with state of the art techniques to assess the diabetic phenotype and cardiac function.

These studies would suit someone with a background in cardiovascular physiology or related field. Experience in preclinical studies and molecular analyses would be ideal.

The PhD candidate will join a dynamic research team working collaboratively within the Cellular and Molecular Cardiology Lab and the Cardiac Research Consortium, a group of 4 research labs in Auckland and Melbourne.

Cellular & Molecular Cardiology Lab
Cardiac Research Consortium

Kim Mellor

Fields of research: Biomedical and clinical sciences; Cardiovascular medicine and haematology; Cardiology (incl. cardiovascular diseases)

Can We Find Blood Biomarkers for GRIN Disorders?

This project aims to identify blood biomarkers for patients with neurodevelopmental GRIN disorders by studying the impact of GRIN1 variants on megakaryocytic differentiation and platelet function using patient samples and model systems.

GRIN disorders are caused by sporadic mutations in GRIN genes encoding the N-methyl-D-aspartate receptor (NMDAR) subunits. Most patients are children, and management is challenging. There are no cures or targeted drugs, and the illness has a significant impact on families. We received funding from the US-based CureGRIN Foundation (ht ps://curegrin.org/) to help identify blood biomarkers for GRIN patients. The project is conducted in collaboration with the University of Toronto (Canada). We use iPSC lines, patient blood samples, and transgenic mouse models to examine the impact of GRIN1 variants on megakaryocytic differentiation and cell stress response. In the medium term, we would like to help diagnose GRIN disorders in New Zealand, as no such testing is currently offered here.

CureGRIN

Maggie Kalev

Project open until: December 2026

Fields of research: Biomedical and clinical sciences; Cardiovascular medicine and haematology; Medical biochemistry and metabolomics; Neurosciences; Haematology; Medical biochemistry - amino acids and metabolites; Cellular nervous system

Development of a Cardiac Fat Model using Clinical MRI for the Possible Prediction of Cardiomyopathy

We aim to quantify fat in various locations of the heart in relation to cardiomyopathy, in order to predict heart dysfunction early.

We aim to establish a magnetic resonance imaging (MRI) method to quantify cardiac fat in the human heart as a possible biomarker for heart failure. Non-invasive MRI can be used to determine cardiac function via ejection fraction calculation and to track morphological changes of heart tissue (i.e. ventricular hypertrophy). We hypothesise that local fat depots within myocardium decrease as heart failure progresses because cardiomyocytes are running out of fuel and utilise local fat as a last resort. We therefore want to identify cardiac fat as a precise and reliable biomarker for cardiac function deterioration in diabetic heart failure. This may detect the onset of heart failure before it happens. The objective is to characterise fat volume in different locations of human heart and its relationship with cardiac function.

Jun Lu

Project open until: July 2025

Fields of research: Biomedical and clinical sciences; Medical physiology; Human biophysics

NO brainer: Nebulised Nitrite as a Novel Therapeutic Treatment for Acute Ischaemic Stroke

Stroke is an incredibly costly disease from human, social, and economic perspectives, yet there are limited treatment options for first-responders. This project will elucidate the effects of nebulised sodium nitrite on brain blood flow control in patients.

Stroke is the third leading cause of death and the leading source of adult disability in New Zealand, with higher rates of death, poorer recovery and early age of stroke onset (by 15 years) in Māori and Pacific populations. While reperfusion treatments at the hospital improve stroke patient outcomes, they can only be given within 4-6 hours of a stroke. Due to long hospital transfers, especially in rural regions, around 85% of all stroke patients of New Zealand do not receive these reperfusion treatments at the hospital. One potential solution is a therapy which can be delivery by first-responders en route to the hospital. But there are currently no stroke treatments available which can be safely and easily given to stroke patients inside the ambulance.

Nitric oxide (NO) is an important biological signalling molecule involved in the control of blood flow, which could be used to improve brain perfusion after a stroke. In a small animal model of stroke, we found that inhaled nitrite reduced stroke infarct volume by ~75% (unpublished), but we do not know whether inhaled nitrite can improve brain perfusion in humans. This is a crucial step for translating this treatment for stroke patients in the real-world. The aim of this project is to elucidate the effects of inhaled nitrite on brain perfusion and vessel function in humans.

Mickey Fan
James Fisher

Project open until: October 2026

Fields of research: Biomedical and clinical sciences; Medical physiology; Systems physiology

Application of Novel Antagonists of the Growth Hormone Signalling in Cancer

Determining the efficacy of growth hormone receptor inhibition in preclinical cancer models.

Radiotherapy, while an important treatment route for many cancers, doesn't work for all patients and resistance to therapy is still a major clinical obstacle. One approach to overcome this is to combine radiotherapy with agents that radiosensitise tumour cells, and for many common cancers, adding novel molecularly targeted agents to radiotherapy tangibly improves outcomes in both the preclinical and clinical setting.

The growth hormone (GH) signalling pathway has emerged as an important mediator of tumour development. GH is a multifaceted hormone that is essential for normal longitudinal growth and plays diverse roles in tissue and organ development, metabolism, cardiac function and neural development. However, this hormone axis has also been implicated in cancer. Expression of GH is detectable in a variety of different human cancers including breast, endometrial and liver cancer, and is associated with reduced overall survival for cancer patients. In xenograft studies we have shown that agents that block the GH receptor are a new class of radiosensitiser. This project will test the efficacy of a novel inhibitor of GH signalling in preclinical cancer studies.

Jo Perry
Yue Wang

Fields of research: Biomedical and clinical sciences; Oncology and carcinogenesis; Cancer cell biology; Chemotherapy; Molecular targets; Radiation therapy

What Drives Megakaryocytic Cancers?

This research, part of the MegBio project, investigates pathogenic mechanisms in megakaryocytic cancers using advanced genomic and biologic studies. It aims to identify novel therapeutic targets to improve patient outcomes.

Megakaryocytic cancers include acute megakaryoblastic leukaemia and selected chronic myeloproliferative neoplasms (essential thrombocytosis and primary myelofibrosis). The pathogenesis of these cancers remains incompletely elucidated, and patient outcomes are often poor.

This research is a part of the MegBio project, which our team developed. We examine patient samples using genome and transcriptome testing approaches and model disease pathogenesis in vitro to uncover novel pathogenic mechanisms that drive disease. Our overriding aim is to identify new targets for treating megakaryocytic cancers.

Megakaryocyte and Platelet Biology Study

Maggie Kalev

Project open until: December 2026

Fields of research: Biomedical and clinical sciences; Cardiovascular medicine and haematology; Oncology and carcinogenesis; Haematology; Cancer cell biology; Cancer genetic; Haematological tumours; Molecular targets

Unlocking the Mysteries of Lymphoedema in Breast Cancer Survivors

Create a digital twin to explore the mechanisms behind lymphoedema development in breast cancer survivors, aiming to enhance understanding and treatment of this under-researched condition.

Breast cancer is the most common cancer among women worldwide. Many patients undergo surgery or radiation therapy to target lymph nodes, to prevent the spread of cancer. While these treatments are often effective, approximately 20% of patients develop lymphoedema – an incurable condition marked by chronic swelling in the arm due to impaired fluid drainage in the lymphatic system. The reasons why some breast cancer survivors develop lymphoedema and others do not remain largely unknown.

Our innovative and cross-disciplinary research team is developing advanced computational models to simulate fluid flow through the lymphatic system, aiming to unravel the complexities of lymphoedema in breast cancer survivors. This cutting-edge project involves acquiring and analysing advanced imaging data, creating physics-based computational models, and utilising world-leading anatomical and statistical atlases of lymphatic anatomy. We are based at the Auckland Bioengineering Institute which has a long track record of developing digital twins to understand human anatomy and physiology.

We invite passionate PhD candidates to contact us to discuss potential projects within this research programme.

Hayley Reynolds

Fields of research: Biomedical and clinical sciences; Oncology and carcinogenesis; Biomedical engineering; Fluid mechanics and thermal engineering; Computational methods in fluid flow, heat and mass transfer (incl. computational fluid dynamics); Image processing

Precision Prostate Cancer Treatment Using MRI Radiomics and AI

Develop MRI radiomic-based imaging biomarkers of treatment response for precision prostate cancer radiation therapy.

Prostate cancer is one of the most common cancers in men worldwide. Stereotactic Ablative Body Radiotherapy (SABR) provides a precise and effective treatment option, delivered in fewer sessions compared to conventional radiation therapy. While SABR has demonstrated high five-year tumor control rates, the risk of local recurrence increases over time, and current monitoring relies on periodic blood tests, which may not detect early signs of recurrence.

To address these challenges, our team is advancing precision radiation therapy for prostate cancer through the Biologically Targeted Radiation Therapy (BiRT) project. This project, in collaboration with the University of Sydney and our group at the Auckland Bioengineering Institute, fosters a rich interdisciplinary research environment. Our goal is to personalize treatment by mapping the patient-specific spatial distribution of cancer using advanced imaging techniques such as multiparametric MRI and PET/CT. By developing quantitative MRI and radiomics-based biomarkers, we aim to assess early response to SABR more accurately. These innovations are being tested in our local clinical trial, with the aim of improving patient outcomes by enabling timely adjustments to radiation therapy.

We encourage enthusiastic PhD candidates to contact us to explore potential projects within this exciting research program.

Hayley Reynolds

Fields of research: Biomedical and clinical sciences; Oncology and carcinogenesis; Biomedical engineering; Machine learning; Medical physics; Radiation therapy; Image processing

Exploring the Posterior Limbal Stem Cell Niche

This project aims to explore interactions between stromal cells in the limbus with adult stem cells for the corneal endothelium, in order to explore non-surgical treatments for corneal endothelial diseases.

Damage or dysfunction of the innermost layer of the cornea leads to loss of vision. Non-surgical treatments for corneal endothelial diseases such as Fuchs' Endothelial Corneal Dystrophy and pseudophakic bullous keratopathy are very limited. Corneal transplantation using donor corneas is the only treatment for end stage diseases, but the availability of donor corneas is low in many regions of the world. Therefore, alternative treatments for corneal endothelial diseases are required.

Adult stem cells for the corneal endothelium have been identified at the back of the limbus, which is the grey area between the cornea and the sclera. However, it is unknown why these cells are unable to regenerate the corneal endothelium when needed. The answer may lie in their surrounding environment. We isolated stromal cells from the posterior limbal stroma and found that they stimulated the proliferation and stemness of the endothelial progenitor cells. This project will investigate the mechanisms of these in vitro cellular interactions, and explore novel therapeutics for corneal endothelial diseases via stimulation of corneal endothelial stem cells.

Jie Zhang
Charles McGhee

Fields of research: Biomedical and clinical sciences; Medical physiology; Medical biotechnology; Ophthalmology and optometry; Ophthalmology; Regenerative medicine (incl. stem cells); Cell physiology

Low Glucose Levels in Babies

Low glucose levels in babies can cause brain damage. This project will analyse large clinical datasets to investigate the relationships between newborn glucose levels and developmental outcomes in childhood.

We know that low glucose levels in newborn babies can lead to brain injury, but we do not know how low these levels need to be for how long in which babies, and whether other factors also influence whether brain injury occurs. This project will analyse large clinical datasets from a number of different studies in babies born at risk of low glucose levels and their later neurodevelopmental skills. The aim will be to develop new understandings about how low glucose levels can lead to brain injury. The findings will potentially inform the development of new clinical practice guidelines. The student will work with an experienced, award-winning multidisciplinary team, and experience all the privileges of a postgraduate student at the Liggins Institute. Suitable candidates will be seeking a project with strong clinical relevance and wanting to learn about the variety of analytical skills that can be applied to clinical datasets. A clinical background and some experience in data analysis or epidemiology would be an advantage but is not essential. Scholarships will be available for suitable candidates.

Jane Harding
Robyn May
Greg Gamble

Project open until: June 2025

Fields of research: Biomedical and clinical sciences; Paediatrics; Infant and child health; Neonatology

Implementing a National Guideline for Neonatal Hypoglycaemia

New national guidelines have been developed for management of low glucose concentrations in newborn babies. This project will involve implementation of these guidelines and assessing their effectiveness.

Neonatal hypoglycaemia is common in the first few days after birth, with 30% of Aotearoa New Zealand babies born at risk. Of those, half will develop hypoglycaemia, with a potential risk of brain damage. There is wide variation in management of neonatal hypoglycaemia across Aotearoa New Zealand. We are developing a national Clinical Practice Guideline that will provide evidence-based recommendations for the prevention, diagnosis and management of neonatal hypoglycaemia to assist health professionals and whānau (family) in caring for newborn babies. This project will build on the work of the Panel developing the Guidelines to implement their recommendations across Aotearoa New Zealand. The project will involve planning an implementation strategy, undertaking implementation activities, and auditing progress. The result will be improving health outcomes for newborn babies, and support consistency and equity across the country. Potential candidates should have a background in health, enthusiasm and a can-do attitude, with qualifications in midwifery, nursing, paediatrics, obstetrics or public health. Experience with Māori or Pacific communities would be valuable. The successful applicant will have the opportunity to work with an experienced multidisciplinary team including Māori and Pacific co-investigators.

Jane Harding
Luling Lin

Project open until: December 2026

Fields of research: Biomedical and clinical sciences; Paediatrics; Neonatology; Infant and child health

Predicting Early Development in Moderate to Late Preterm Babies

Babies born moderate-late preterm are at risk of developmental problems, but the reasons for this are unknown. This project will investigate how clinical factors and early MRI are related to later development.

Over 80% of preterm babies are born between 32- and 36-weeks' gestation: moderate-late preterm. These babies have increased risk of disability, but the reasons are not known. Moderate-late preterm babies do not have routine brain scanning after birth, and rarely have any follow-up after going home. However, we have found that many have changes on brain MRI soon after birth, although these have often disappeared by term-equivalent age. The causes, incidence and significance of these changes are not known. The aim of this project is to find out whether these changes on brain MRI are markers of later adverse outcomes. If so, this would represent a breakthrough in understanding the problems that moderate-late preterm babies face, and provide opportunities for early intervention to reduce later disability.

Objectives: In moderate-late preterm babies: 1. Determine the incidence, size and distribution of brain changes on MRI 2. Investigate possible causes before and after birth 3. Assess development at 3 months of age 4. Assess outcomes at 2 years 5. Relate outcomes to MRI changes and 3-month assessments

Other information: Candidates may have an interest in and experience with MRI, babies or young children, nurses, doctors, midwives, psychologists, physiotherapists, and developmental therapists.

Moderate-to-late Preterm Babies Early Brain Development

Jane Harding
Sian Williams

Project open until: June 2025

Fields of research: Biomedical and clinical sciences; Paediatrics; Neurosciences; Neonatology; Infant and child health; Central nervous system

Understanding the Role of Leptin in Tendon Healing

This project aims to determine whether circulating leptin concentrations correlate to poor surgical outcomes after rotator cuff repair, and explore its mechanisms of action.

Recent studies have demonstrated that people with obesity have poor tendon health and healing. Recently, our research group undertook a pre-clinical study to bet er understand the links between obesity and rotator cuff tendon healing in the shoulder. We demonstrated that rats fed a high fat diet (HFD) had much poorer healing outcomes after rotator cuff surgery than those on a normal diet. We further used this study to identify potential biochemical interactions, and identified circulating leptin as the only biochemical marker which correlated with poor histological structure, and reduced mechanical strength of the repaired rotator cuff.

Based on this work, we hypothesise that higher levels of leptin pre-surgery will correlate with poorer outcomes following rotator cuff surgery, and that leptin will have direct negative effects on tendon cells.

To explore these novel hypotheses, this research project aims to:

1. Take blood samples from people undergoing rotator cuff repair surgery, and determine whether circulating leptin concentrations correlate to poor surgical outcomes post-surgery.
2. Study the mechanism of effect, by undertaking a series of in vitro studies to determine the direct effects of exogenous leptin on human tendon cells.

David Musson

Fields of research: Biomedical and clinical sciences; Biological sciences; Clinical sciences; Orthopaedics; Biochemistry and cell biology; Cell metabolism

Can Dietary Anti-Inflammatory or Anti-Oxidant Nutrients Protect Against or Improve Tendinopathy

Tendon disease (tendinopathy) is associated with inflammation, increased reactive oxygen species, and mitochondrial dysfunction at the cellular level. This project will explore whether dietary factors can combat these.

Tendinopathy is one of the most commonly diagnosed musculoskeletal disorders, and is increasing in incidence. It is often associated with sporting populations, but disproportionately effects older people, those with obesity, and those who spend prolonged periods inactive.

The underlying causes of tendinopathy are multifactorial and are still not entirely known. However, at the cellular level increased pro-inflammatory factors, reactive oxygen species, and factors which disrupt the structure of the tendon matrix are produced, and dysregulated mitochondrial function has been reported.

While obesity has been negatively linked to tendon health, lit le has been done to explore whether diet can be used to protect against increased risk of tendinopathy, or as a treatment to improve healing once tendinopathy is present.

In this research project, we propose to study dietary factors with anti-inflammatory or anti-oxidant properties in in vitro models of tendon pathology. The aim is to determine whether their presence can protect tendon and immune cells from pathological states, or whether they can improve cellular functions once a pathological state has been induced.

Should in vitro studies be positive, there is scope to translate this to pre-clinical models, or preliminary clinical study.

David Musson
Chris Hedges

Fields of research: Biomedical and clinical sciences; Biological sciences; Nutrition and dietetics; Food properties (incl. characteristics and health benefits); Biochemistry and cell biology; Cell metabolism

Novel Chronic Wound Management Using Nanocarrier-Enriched Hydrogel

Chronic wounds are a global health concern, affecting 2% of New Zealanders. Our research aims to develop a nanocarrier-enriched hydrogel to deliver natural compounds for improved wound healing and reduced inflammation.

Chronic wounds represent a significant global health issue, affecting approximately 2% of the New Zealand population and contributing to substantial healthcare costs, with the local wound care market projected to reach $9.87 million in 2024. This research seeks to address this critical challenge through the development of an innovative treatment utilizing a hydrogel enriched with nanocarriers. These nanocarriers are engineered to deliver potent natural bioactive compounds directly to the wound site, thereby enhancing the wound healing process. The hydrogel formulation will incorporate a polymer known for its anti-inflammatory properties, which aids in reducing pain and inflammation. By integrating advanced nanocarrier technology with natural bioactives, this approach aims to offer a more effective and targeted therapeutic option for chronic wounds, with the potential to significantly improve clinical outcomes and revolutionize wound care practices.

Jingyuan Wen
Mengyang Liu
Sara Hanning

Fields of research: Biomedical and Clinical Sciences; Pharmacology; Pharmaceutical sciences

Discovering New Treatments for Heart Disease

This research project aims to investigate the underlying mechanisms of heart disease to identify new treatment targets and develop novel therapeutics.

Preclinical mouse models of disease will be used to map molecular changes that link with functional outcomes. A range of techniques will be employed to study disease states at the molecular, cellular and whole heart levels. This work involves cutting edge methodologies and international collaborations. There will be exciting opportunities to present the findings at international conferences and work with high-profile scientists around the world.

Cardiac Research Consortium
Cellular Molecular Cardiology Research Lab

Kim Mellor

Fields of research: Biomedical and clinical sciences; Cardiovascular medicine; Cardiology (incl. cardiovascular diseases)

Using Umbilical Stem Cells to Regenerate the Cornea in Keratoconus

This project investigates whether human umbilical stem cells can incorporate into corneal tissue and regenerate corneal matrix in human diseased tissue, particularly keratoconus.

Keratoconus is characterised by loss of stromal matrix and cells from the cornea which results in the distended cone-shaped cornea and loss of vision for the patient. Current treatments focus on stabilising the cornea to prevent further loss of matrix and hence any further change in corneal shape. We are investigating the use of umbilical mesenchymal stem cells (MSCs) to not only stabilise the cornea but to regenerate the lost matrix and restore any visual loss. To do this the MSCs need to first survive and then integrate into corneal tissue followed by differentiation into corneal stromal cells and then produce corneal matrix. We are investigating the mechanisms that allow the MSCs to follow this path to corneal differentiation using human umbilical cells and human corneal tissue in the laboratory in an ex vivo organotypic model of the cornea.

Trevor Sherwin

Fields of research: Biomedical and clinical sciences; Medical biotechnology; Regenerative medicine (incl. stem cells); Ophthalmology and optometry; Ophthalmology

How the Molecular Mechanisms Driving Osteoarthritis Differ Between Males and Females: Implications for Disease Treatment

This project will utilise tissue obtained from patients with osteoarthritis to determine how the cellular mechanisms driving osteoarthritis development differ between male and female patients.

Osteoarthritis (OA) is the leading cause of physical disability in adults worldwide, affecting approximately 1 in 3 women and 1 in 4 men. Despite its prevalence, there remain no disease modifying drugs with proven effectiveness for treating OA. OA results in loss of cartilage within articular joints. One of the major drivers of this cartilage loss is increased cartilage catabolism by chondrocytes due to a change in chondrocyte phenotype in disease. Our group recently showed that the phenotype of OA chondrocytes differs between male and female patients. Chondrocytes from male patients have a much higher capacity for new cartilage synthesis whereas chondrocytes from females appear to have a greater propensity for invoking defensive mechanisms such as inflammation. Our data indicates that the pathways driving OA differ between males and females with the implication that a different strategy is needed to treat OA in males versus females. This project will involve the isolation and culture of chondrocytes from human cartilage and the use of pharmacological and molecular biology strategies to determine how the activity of pathways such as transforming growth factor (TGF) and inflammation differ in OA between male and female patients.
DOI: 10.1016/j.joca.2023.09.013

Raewyn Poulsen

Fields of research: Biomedical and clinical sciences; Medical physiology; Cell physiology; Pharmacology and pharmaceutical sciences; Basic pharmacology

Physical Rehabilitation and Environmental Enrichment to Enhance Regenerative Treatments for Spinal Cord Injured Rats

To develop, test and deploy methods to provide physical rehabilitation and systematic environmental enrichment with an emphasis on promoting hind leg activity in spinal cord injured rats.

At the School of Pharmacy, University of Auckland, we are developing electroceutical, pharmaceutical, and cell-based regenerative treatments for spinal cord injury (SCI) using rodent models. Physical rehabilitation is an important aspect of recovery after SCI and can specifically enhance regenerative treatments by promoting viable axon reconnection while pruning incorrect reconnections of sensory with motor fibres. Exposure to enriched environments has been shown to increase exercise and may further enhance the capacity for recovery through increased social interaction and environmental stimulation. The PhD student will develop, test and deploy methods to provide physical rehabilitation and systematic environmental enrichment with an emphasis on promoting hind leg activity in spinal cord injured rats. In addition to this focus on developing new methods for physical rehabilitation and enrichment, the PhD candidate will have the opportunity to be involved with spinal cord implantation and injury surgeries, postoperative care, behavioural testing and analysis, recording and stimulating spinal cord neural activity in awake freely moving rats, building and benchtop testing of implants and in vitro application of electric fields
ht ps://doi.org/10.1002/advs.202105913

Bruce Harland
Darren Svirskis

Fields of research: Biomedical and clinical sciences; Medical biotechnology; Regenerative medicine (incl. stem cells); Neurosciences; Central nervous system

The Effect of Nutrition on the Progression of Parkinson's Disease

This project will investigate the role of dietary patterns on motor and non motor symptoms in Parkinson's disease.

This project aims to explore the impact of dietary pat erns on both motor and non-motor symptoms in Parkinson's disease. By focusing on specific dietary components and their effects, the study will assess how dietary intake influences symptom progression, quality of life, and overall health outcomes. The research will involve both qualitative and quantitative methodology to identify potential dietary interventions that could alleviate symptoms and slow disease progression. The ultimate goal is to provide evidence-based dietary recommendations for people with Parkinson's disease.

Parkinson's Disease - Diet & Nutrition
The Gut-Brain Connection: Why Diet Can Help Parkinson's Symptoms & Brain Health

Fiona Lithander

Fields of research: Biomedical and clinical sciences; Neurosciences; Neurology and neuromuscular diseases; Nutrition and dietetics; Clinical nutrition

Mate Whenua: Follow up after Early Medical Abortion

This is a clinical trial in New Zealand comparing two methods of follow up after early medical abortion.

Early medical abortion (EMA) is safe and effective; an uncommon but crucial outcome is ongoing live pregnancy. The best method of follow up after EMA to detect ongoing pregnancy is a critical research gap. Few trials compare blood or urine pregnancy tests to ultrasound scan, and no trial compares these tests to each other.

Aim: To evaluate two methods of follow up after EMA.

Research question/s: In women having EMA at eight abortion services across New Zealand, will self-assessment with low sensitivity urine pregnancy test result in more complete follow up compared to serial serum blood tests? Will this new method be as safe, and will it be as effective at detecting ongoing pregnancy? Will women having EMA find it to be a more acceptable method of follow up?

Study design: multicentre randomised controlled trial

Ethics approved. Funded by HRC. Recruiting at 6 sites, estimated to complete recruitment in August 2025. Potential for secondary analyses after the RCT is complete.

Mate Whenua

Funding: Scholarship from project

Fields of research: Biomedical and clinical sciences, Reproductive medicine; Obstetrics and gynaecology

A Three-dimension Whole-cell Perspective on Atrial Fibrillation

Atrial fibrillation is a chaotic heart rhythm disorder increasing stroke and heart failure risk. This PhD project aims to map atrial cellular properties using advanced 3D imaging.

Atrial fibrillation (AF) - chaotic activity in the upper atrial chambers of the heart that results in an irregular heartbeat - increases the risk of heart failure and stroke. Despite extensive research over many decades, treatment remains suboptimal. A bet er understanding of atrial cellular properties is needed for effective pharmacologic rhythm control in patients with AF. Atria are complex and vary considerably in cellular structure and electrical properties. By leveraging our recent advances in high-throughput 3D super-resolution imaging, we seek to address key limitations of previous work, which has looked at a small number of individual cells without capturing variability between them. In this PhD proposal, the PhD student is expected to conduct functional mapping of the rat atria (both disease and control groups) at the cell to tissue/organ level and image the rat atria throughout to understand the precise role of atrial tubules (invaginations of the cell membrane that propagate the conduction of the action potential into the interior of the myocyte) in AF.

The aims of this project are to

1. Conduct cell-to-tissue level functional mapping of atria to link atrial subcellular structural heterogeneity to AF using state-of-the-art optical mapping and confocal microscopy.
2. Characterise the spatial distribution and cell-to-cell heterogeneity of atrial tubules in large populations of atrial cells throughout the rat atria using automated super-resolution imaging and AI.

This project can significantly improve our understanding of AF and potentially enhance the efficacy of AF treatment.

Ideal candidates will have a Masters or a Bachelors degree in Biomedical Engineering, Medical Physics Biology, Neuroscience, or related fields and be interested in super-resolution imaging, and basic programming skills.

Jichao Zhao
David Baddeley

Funding: Scholarship from project

Project open until: December 2026

Fields of research: Biomedical and clinical sciences; Cardiovascular medicine and haematology; Cardiology (incl. cardiovascular diseases); Biomedical engineering; Biomedical imaging

Electrical Arrhythmia in the Right Side of the Heart

Detailed analysis of function, features and mechanisms in the right side of the heart will show why it is a source for inherited and acquired diseases causing electrical rhythm disturbances.

The right ventricle (RV) of the heart and the RV outflow tract (RVOT) to the pulmonary artery are often associated with electrical malfunction. For example, ROVT tissue has variable protein distributions and discontinuities assumed to be pro-arrhythmic. The RV/RVOT are often sites of inherited malfunctions such as Brugada Syndrome and arrhythmogenic RV cardiomyopathy and dysplasia (ARVC/D), but data and understanding of these conditions are missing. The RV is also susceptible to acquired effects from pulmonary diseases, such as pulmonary hypertension, which eventually lead to right heart failure. It is possible that pulmonary diseases cause changes and increase arrhythmic risks in the RV before failure occurs. There are many unanswered questions. To understand the mechanisms of arrhythmia in the RV, a range of data are collected. These include signal recordings from normal and diseased hearts, blood biomarkers and microscope images of protein distributions, cell architecture, tissue scarring and fat depositions. To make sense of these data, computer models of tissue structure and electrical function will be indispensable. This is a unique opportunity to be part of a project finding insights into clinical health problems, using computational engineering and science applied to advanced functional and imaging data.

Cardiac measurements, tissue imaging and electrical modelling

Mark Trew

Fields of research: Biomedical and clinical sciences; Cardiovascular medicine and haematology; Cardiovascular medicine and haematology; Engineering; Biomedical engineering; Computational physiology

Examining the Effects of Optical Defocus on Microglial Activation and Inflammatory Responses in Alzheimer's Disease

This project investigates how optical defocus affects microglial activation and inflammation, revealing potential links to Alzheimer's disease pathology and offering new insights for therapeutic interventions.

Abnormal microglial activation is a critical feature in the pathogenesis of Alzheimer's disease (AD), contributing significantly to neuroinflammation and neuronal damage. This project aims to elucidate how optical defocus—an experimental paradigm that mimics visual disturbances—affects microglial activation and inflammatory responses, with implications for AD pathology. Using a well-established microglial cell line, we will subject these cells to simulated optical defocus conditions to systematically assess alterations in microglial activation, cytokine secretion, and signalling pathways associated with neuroinflammation and cell death. By correlating these findings with established biomarkers of AD, this study seeks to uncover potential mechanisms through which visual disturbances might exacerbate or modulate neuroinflammatory processes relevant to AD. The results are applicable to thereby offering new avenues for therapeutic intervention and understanding of the disease's aetiology.

Monica Acosta

Project open until: February 2025

Fields of research: Biomedical and clinical sciences; Health sciences; Public health; Vision science; Ophthalmology and optometry not elsewhere classified; Sensory systems; Other health sciences; Cellular nervous system

Associations Between the Food Environment and Eating Behaviour in Relation to Socioeconomic Status Among Young Adults in Urban Settings of China, New Zealand and Australia

The project's objective is to perform an extensive, cross-country examination of the food environments for young adults and their influence on dietary behaviors in China, New Zealand, and Australia.

Specific Objectives:

1. Assess and Compare Food Environments: Conduct audits using validated tools to assess food environments across universities in the three countries.
2. Analyse the Influence of Socioeconomic status on Dietary Behaviours: Examine the relationship between food environments, socioeconomic status, and student dietary behaviours through surveys and data analysis.
3. Design Culturally Tailored Interventions: Develop and propose intervention strategies that are contextually relevant to each country, focusing on improving food availability, cooking methods, and nutrition education.

Andrea Braakhuis

Project open until: October 2025

Fields of research: Biomedical and clinical sciences; Nutrition and dietetics; Public health nutrition; Health sciences

Using Artificial Intellegence to Improve In-Vitro Fertilisation

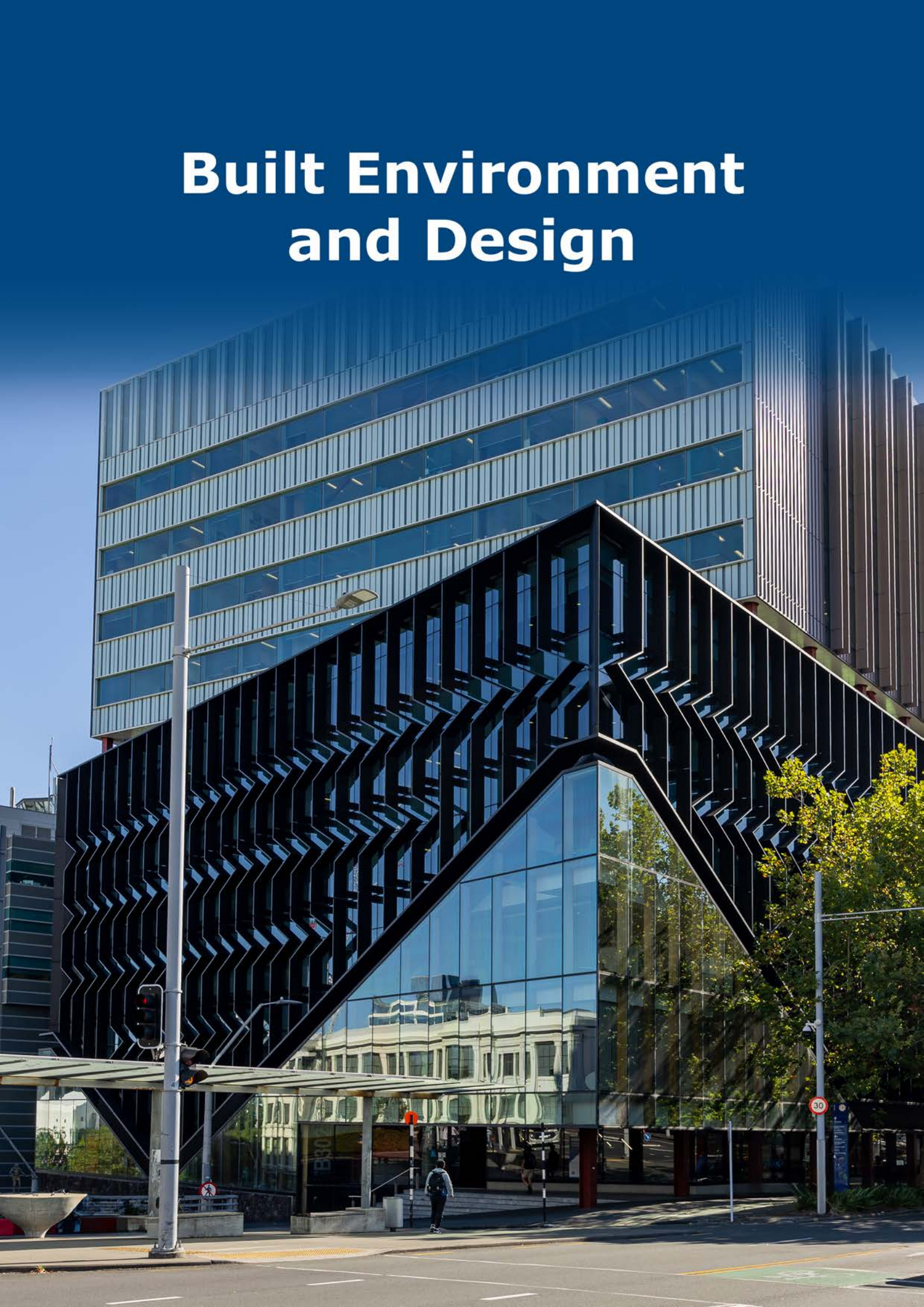
Creating models to improve embryo selection by leveraging a large proprietary database of millions of human and animal embryo images linked with fertility outcomes.

This project will explore how AI models can be enhanced with clinical and objective image information to improve embryo selection and thus fertility. Data available will include images, clinical features, and non-invasive biomarkers to allow the development of multi-modal AI models. Candidates should have a strong knowledge of Python and understand the basics of Deep Learning approaches.

Nicholas Knowlton
Lynsey Cree

Fields of research: Biomedical and clinical sciences; Reproductive medicine; Reproduction; Mathematical sciences; Statistics; Statistical data science

Built Environment and Design



Architecture for, by and with the Poor: Enhancing Housing Resilience to Buffer Inequality and Climate Change Issues

The project investigates the design challenges of providing housing for the bottom 50% of the population that can be gentle with the environment, fair and just. The final aim is to contribute to the development of vulnerable communities by enhancing their resilience capacity through an architectural design that is sustainable.

The project looks at investigating ways of designing for bot om 50% of the population to end poverty and bridge inequality gaps. Architecture by, for and with the poor has been overlooked for decades, abandoned by the State, forgot en by architects in their education and practice and left at the mercy of private interests. Since housing is key to avoid being asset-poor after retirement and can help communities to increase their quality of life, it is essential to have a clear understanding of the social ecological design challenges to contribute to ending poverty. The project will document the current situation, unravel the existing gaps in the knowledge and contribute to developing clear guidelines to the production of housing design through resilience thinking.

Emilio Garcia

Fields of research: Built environment and design; Architecture; Sustainable architecture; Environmental Sciences; Climate change impacts and adaptation

Chemical Sciences

Green Chemical Science for a Sustainable Future

Green Chemical Science is the use of chemical principles, science and technology to advance society in ways that are benign to the environment and sustainable for the foreseeable future.

Globally, humanity faces many challenges such as pollution, resource depletion, energy demands, inadequate food supply and lack of clean water.

Our research aims to address these challenges by using Green Chemical Science approaches to develop sustainable solutions. We focus on the use of renewable feedstocks, methods of pollutant remediation, designing environmentally benign chemical synthesis and reducing waste in food production and storage.

Research areas include:

- Use of renewable feedstocks
- Sustainable chemical synthesis
- Reducing and reusing food waste
- Remediation of pollutants
- Renewable energy production and storage

Follow this link to explore **academic staff in Green Chemistry**

General questions can be sent to:
Dan Furkert
David Barker

Fields of research: Chemical sciences; Analytical chemistry; Inorganic chemistry; Macromolecular and materials chemistry; Medicinal and biomolecular chemistry; Organic chemistry; Theoretical and computational chemistry; Biologically active molecules; Biomolecular modelling and design; Cheminformatics and quantitative structure-activity relationships; Molecular medicine; Proteins and peptides; Characterisation of biological macromolecules; Bioinorganic chemistry; Crystallography; F-block chemistry; Inorganic green chemistry; Main group metal chemistry; Metal cluster chemistry; Metal organic frameworks; Non-metal chemistry; Organometallic chemistry; Solid state chemistry; Transition metal chemistry; Inorganic materials (incl. nanomaterials); Macromolecular materials; Nanochemistry; Optical properties of materials; Physical properties of materials; Polymerisation mechanisms; Structure and dynamics of materials; Supramolecular chemistry; Theory and design of materials

Advanced Materials and Technologies

Materials science addresses many of the challenges facing modern society by developing new substances for use in areas such as sustainable living, the environment, energy and health.

This highly interdisciplinary field of research combines chemistry, physics, biology, medicine and engineering to understand and design desired properties in the development of new substances.

Our research in advanced materials and technologies comprises the synthesis, characterisation and applications of new functional materials including self-assembled peptide systems, polymers, catalysts for energy applications, and novel inorganic/magnetic materials. Electrochemical synthetic methods and studies of material degradation such as corrosion science, are an important part of this work.

Research areas include:

- Solid-state inorganic materials
- Energy materials and catalysis
- Functional polymeric materials
- Bioactive materials and coatings
- Surfaces, including biological systems
- Electrochemical characterisation and synthesis of materials
- Dynamic microfluidics and nanofluidics

Follow this link to explore **academic staff in Advanced Materials**

General questions can be sent to:
Dan Furkert
David Barker

Fields of research: Chemical sciences; Analytical chemistry; Inorganic chemistry; Macromolecular and materials chemistry; Medicinal and biomolecular chemistry; Organic chemistry; Theoretical and computational chemistry; Bioinorganic chemistry; Crystallography; F-block chemistry; Inorganic green chemistry; Main group metal chemistry; Metal cluster chemistry; Metal organic frameworks; Non-metal chemistry; Organometallic chemistry; Solid state chemistry; Transition metal chemistry; Inorganic materials (incl. nanomaterials); Macromolecular materials; Nanochemistry; Optical properties of materials; Physical properties of materials; Polymerisation mechanisms; Structure and dynamics of materials; Supramolecular chemistry; Theory and design of materials

Pushing the Boundaries of Fundamental Chemistry

Fundamental research in the School of Chemical Sciences spans all areas of chemistry to advance knowledge, better understand the universe and seed development of the next generation of technological breakthroughs.

Chemistry is often referred to as the central science, given the strong connections between chemistry and the other natural sciences.

Our research focuses on advancing the current understanding of chemical science in terms of explaining the mechanisms of reactions, developing new methods in chemical synthesis, uncovering novel aspects of molecular structure and, revealing different modes of chemical bonding.

Our fundamental discoveries help propel chemistry as the central science by facilitating interdisciplinary outcomes in areas such as chemical biology and chemical physics.

Research areas include:

- Chemical bonding and intermolecular forces
- Chemical synthesis and catalysis
- Reaction mechanisms
- Photochemistry
- Biochemical reactions
- Organocatalysis
- Mechanochemistry
- Electrochemistry

Follow this link to explore **academic staff in Fundamental Chemistry**

General questions can be sent to:
Dan Furkert
David Barker

Fields of research: Chemical sciences; Analytical chemistry; Inorganic chemistry; Macromolecular and materials chemistry; Medicinal and biomolecular chemistry; Organic chemistry; Theoretical and computational chemistry; Biologically active molecules; Biomolecular modelling and design; Cheminformatics and quantitative structure-activity relationships; Molecular medicine; Proteins and peptides; Characterisation of biological macromolecules; Bioinorganic chemistry; Crystallography; F-block chemistry; Inorganic green chemistry; Main group metal chemistry; Metal cluster chemistry; Metal organic frameworks; Non-metal chemistry; Organometallic chemistry; Solid state chemistry; Transition metal chemistry; Inorganic materials (incl. nanomaterials); Macromolecular materials; Nanochemistry; Optical properties of materials; Physical properties of materials; Polymerisation mechanisms; Structure and dynamics of materials; Supramolecular chemistry; Theory and design of materials

Innovations in Food and Beverages: Wine Science and Food Science

The phrase "We are what we eat" reflects the important role food and beverage play in our lives. This area of research covers food and beverage properties, agricultural and production practices, and food safety.

Our research covers a wide range of products, including fruits and vegetables, seafood, meat products, dairy, and wine.

Using a fundamental approach, we investigate food structure, macromolecular interactions and their properties, functionalities and digestive at ributes, and the biosynthesis of bioactive molecules.

Our applied research with New Zealand companies focuses on the stabilisation of functional ingredients and their application in functional foods. We are investigating quality parameters in wine, and differences in wine styles, including the impacts of winemaking processes involved in yeast fermentation. Our wine research maintains close links to the New Zealand wine industry and the export success of sauvignon blanc and pinot noir wines in particular.

Key research areas include:

- Structure and functionality of food macro-components
- Bioactives and functional food
- Food processing, quality and safety
- Sustainability in agricultural and food systems
- Wine analysis
- Yeast metabolism
- Winemaking factors

Follow this link to explore **academic staff in Food and Beverage Science**

General questions can be sent to:
Dan Furkert
David Barker

Fields of research: Chemical sciences; Biological sciences, Analytical chemistry; Macromolecular and materials chemistry; Medicinal and biomolecular chemistry; Organic chemistry; Theoretical and computational chemistry; Biologically active molecules; Biomolecular modelling and design; Cheminformatics and quantitative structure-activity relationships; Molecular medicine; Proteins and peptides; Characterisation of biological macromolecules; Physical properties of materials; Polymerisation mechanisms; Structure and dynamics of materials; Supramolecular chemistry; Industrial biotechnology; Microbiology

Forensic Science

Forensic Science is the application of science to matters of law.

As our knowledge and technical expertise in science increases, so does the complexity and importance of the science presented to the courts in the legal system. The Forensic Science programme is jointly run by the University of Auckland and the Institute of Environmental Science and Research (ESR) (the suppliers of forensic science to the New Zealand Police).

Forensic Science covers a broad range of topics, from the statistical evaluation of glass evidence to the development of new molecules to aid in the visualisation of fingerprint residues.

Research areas include:

- Environmental forensic science
- Field science
- Forensic biology
- Illicit drugs and drug chemistry
- Physical evidence

Follow this link to explore **academic staff in Forensic Science**
Postgraduate study options
Doctoral study options

General questions can be sent to:
SallyAnn Harbison

Fields of research: Chemical sciences; Biological sciences; Analytical chemistry; Inorganic chemistry; Macromolecular and materials chemistry; Medicinal and biomolecular chemistry; Organic chemistry; Theoretical and computational chemistry; Biologically active molecules; Biomolecular modelling and design; Cheminformatics and quantitative structure-activity relationships; Molecular medicine; Proteins and peptides; Characterisation of biological macromolecules; Bioinorganic chemistry; Crystallography; F-block chemistry; Inorganic green chemistry; Main group metal chemistry; Metal cluster chemistry; Metal organic frameworks; Non-metal chemistry; Organometallic chemistry; Solid state chemistry; Transition metal chemistry; Inorganic materials (incl. nanomaterials); Macromolecular materials; Nanochemistry; Optical properties of materials; Physical properties of materials; Polymerisation mechanisms; Structure and dynamics of materials; Supramolecular chemistry; Theory and design of materials

Chemical Sciences for Human Health

Advances in chemical science underpin all aspects of modern medicine from disease treatment to sanitation, diagnosis, detection and the understanding of disease mechanism and progression.

To ensure healthcare development keeps pace with the many healthcare challenges facing our society, novel chemical science research is vital. We dedicate our research to making an impact in this area both locally and internationally.

Research topics include:

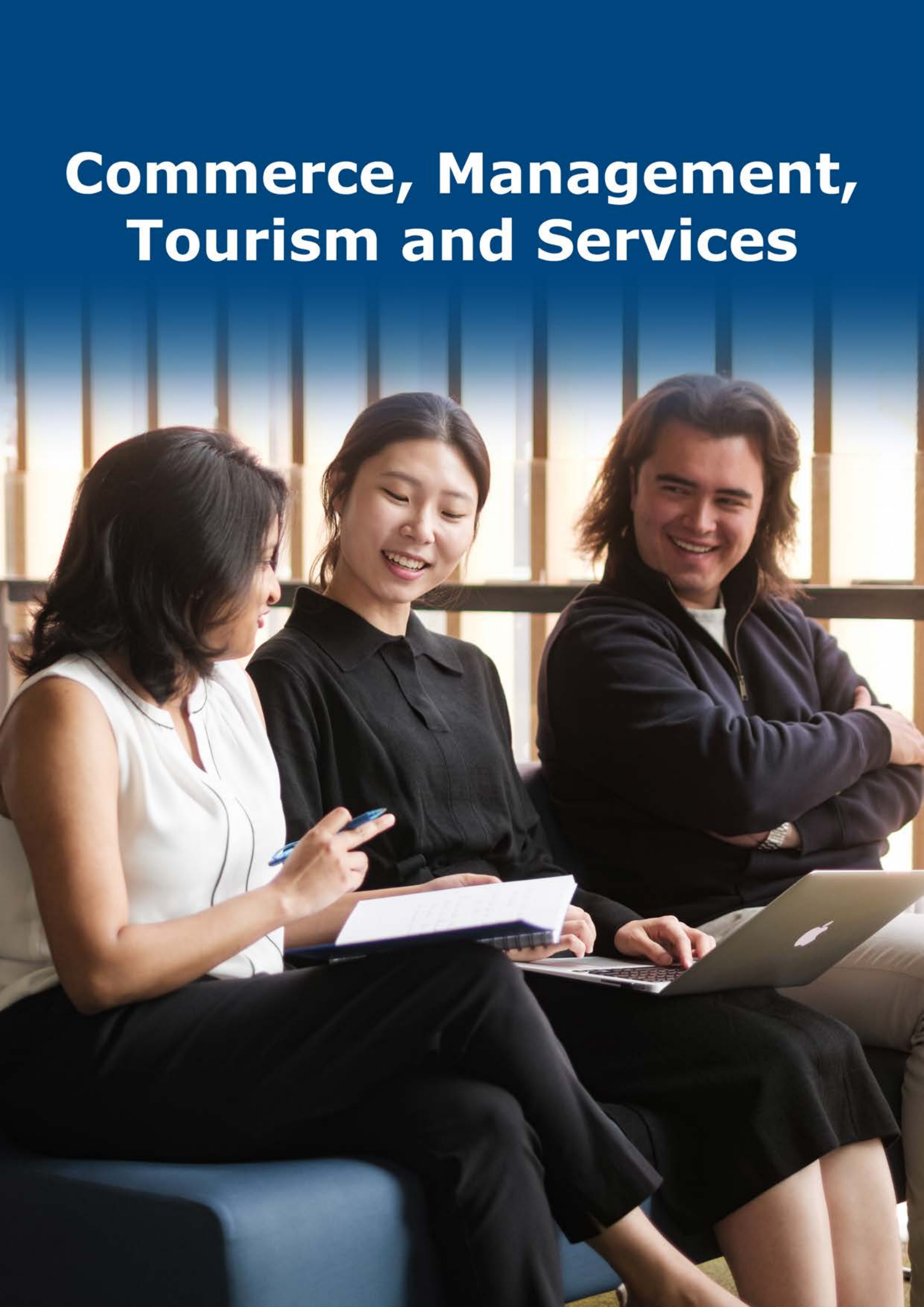
- Cancer
- Infectious disease and antimicrobials
- Diabetes and obesity
- Target identification and drug discovery
- Organic reaction mechanisms
- Natural products
- Enzyme biochemistry
- Devices and sensors

Follow this link to explore **academic staff in Chemical Sciences for Human Health**

General questions can be sent to:
Dan Furkert
David Barker

Fields of research: Chemical sciences; Health sciences; Analytical chemistry; Inorganic chemistry; Macromolecular and materials chemistry; Medicinal and biomolecular chemistry; Organic chemistry; Theoretical and computational chemistry; Biologically active molecules; Biomolecular modelling and design; Cheminformatics and quantitative structure-activity relationships; Molecular medicine; Proteins and peptides; Characterisation of biological macromolecules

Commerce, Management, Tourism and Services



Future of Marketing Work

The roles of marketing employees and the marketing function are being transformed by the technologies of the Fourth Industrial Revolution, including Generative AI, chatbots, robotics, and more.

In today's rapidly evolving business landscape, both professionals and researchers are increasingly investing in intelligent automation (IA) and AI technologies. These include service robots, robotic process automation, generative AI, machine learning, and cognitive computing. The potential of AI and IA to revolutionize marketing operations is immense, and major technology leaders like Alphabet, Meta, Amazon, and Microsoft are at the forefront of this innovation.

A prime example is Microsoft's multibillion-dollar investment in OpenAI, the creator of ChatGPT, which underscores the growing importance of IA. Microsoft's Copilot initiative aims to seamlessly integrate AI and automation across various marketing functions—from sales and customer service to online commerce, customer insights, supply chain management, content generation, and strategic marketing planning.

As a PhD student in this cutting-edge field, you could explore diverse research avenues, such as:

Managing with Intelligent Automation: Investigate the types and roles of marketing automation technologies within organizational processes and assess their impact on employee workflows and workplace ethics.

AI-first Marketing Strategies and Digital Transformation: Analyze how marketing automation influences company brands and corporate communication, and examine the alignment of these automated processes with brand values and ethical standards.

Algorithmic Customer Experience Management: Explore how the collaboration between human and digital employees can create seamless and personalized brand experiences for customers and stakeholders.

By joining this programme, you'll position yourself at the intersection of technology and marketing, driving innovations that will shape the future of marketing work.

Future of Marketing Work

Laszlo Sajtos

Fields of research: Commerce management tourism and services; Marketing; Marketing technology

Retailing Structure on the Online Marketplaces

We aim to study brands' supply chain design on the online marketplaces like franchising, authorized selling, etc.

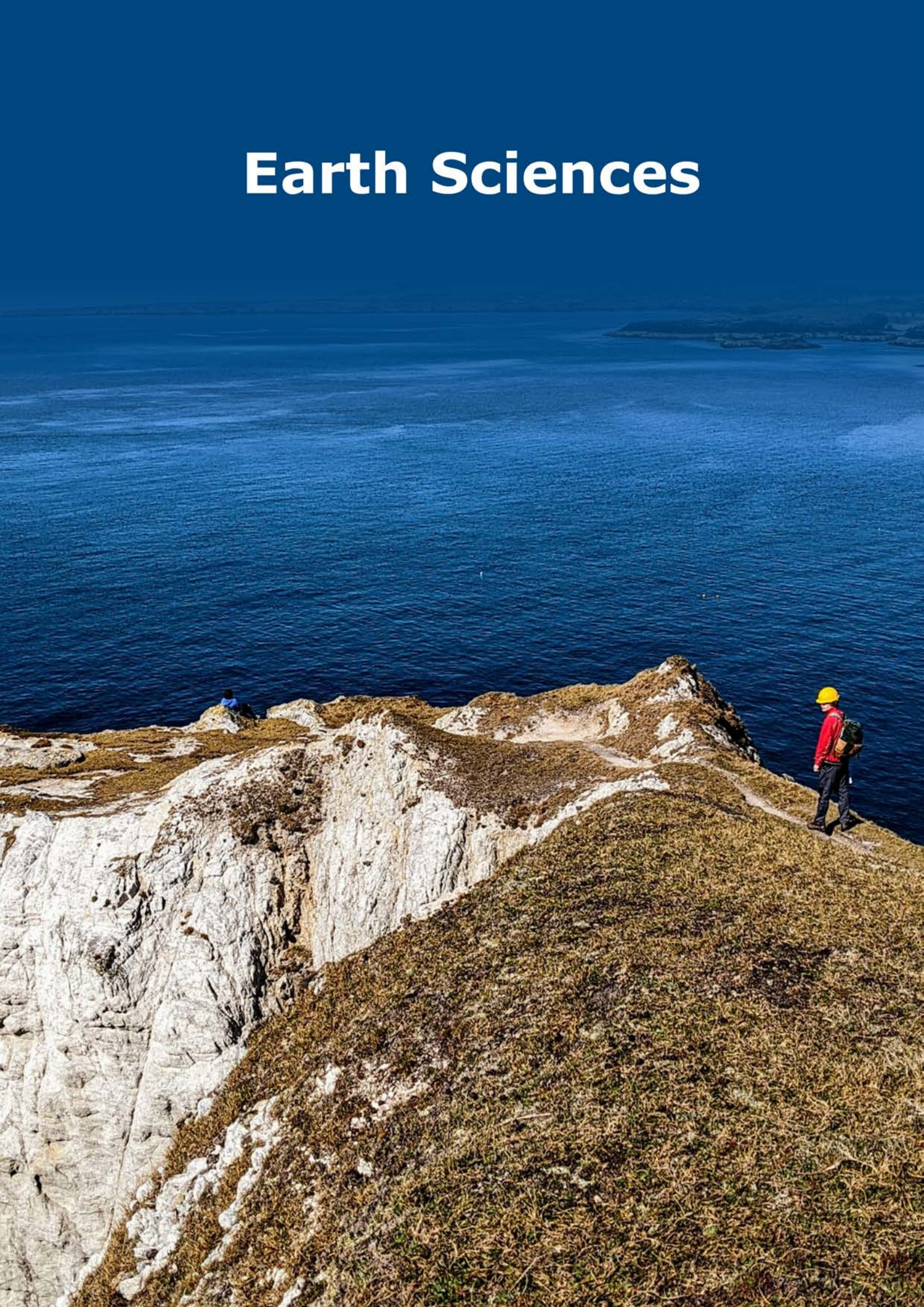
This project aims to examine the supply chain design strategies of brands operating on online marketplaces, with a focus on models such as franchising and authorized selling. The goal is to understand how different supply chain structures impact brand integrity, customer experience, and overall market performance.

Sylvia Gao

Project open until: December 2025

Fields of research: Commerce management tourism and services; Marketing; Marketing theory

Earth Sciences



Subsurface Ice and Water on the Moon and Mars: Imaging with Seismic Waves

Large numbers of seismic and meteor impact events have been recorded on Mars and the Moon. This project looks at unraveling the physical properties of crustal rocks in these planetary body and explore the potential for subsurface water and/or ice.

The project will use analogue volcanic and sedimentary rocks to those on Mars and the Moon. Experimental measurements of elastic waves will be performed at cryo-conditions and at subsurface pressures. The dataset will be used to estimate elastic wave speeds and at enuation which will be used to refine interpretations of the Martian and Moon crust. This will be supported by microstructural analysis of the analogue rocks. Numerical modeling of wave propagation to compare to field observation will also be performed.

Ludmila Adam

Project open until: January 2027

Fields of research: Earth sciences; Geophysics; Petrophysics and rock mechanics; Seismology and seismic exploration

Coastal Processes Research

We have a range of topics available for students interested in Coastal Processes Research at the University of Auckland, please contact us to arrange the detail.

- Understanding the drivers of coastal flooding (Giovanni Coco)
- Spatial and temporal variability of shoreline change (Giovanni Coco)
- Determining drivers of historical coastal change in New Zealand (Emma Ryan)
- Quantifying reef vertical accretion rates on Pacific coral reefs using photogrammetry (Emma Ryan)
- Resolving wave driven coastal cliff erosion with physical model experiments (Mark Dickson)
- Understanding marine heat waves in shallow estuarine and coastal environments (Karin Bryan)
- Tracking the spatial footprint of river plumes in the coastal ocean (Karin Bryan)

Coast And Ocean Collective
Coastal Change

Karin Bryan
Mark Dickson
Giovanni Coco
Emma Ryan

Fields of research: Earth sciences; Environmental sciences; Physical geography and environmental geoscience; Geomorphology and earth surface processes; Climate change impacts and adaptation; Climate change impacts and adaptation not elsewhere classified

Economics


3:31
20%
CTRM NASDAQ
Castor Maritime Inc
1.470
-0.260
-15.03%
Lv2
+1.335 (+988.89%) Last 3M
OPEN/PREV CLOSE
1.540 / 1.730
DAY'S RANGE
1.350-1.580
VOLUME
200.34M
1D 5D 1M 3M 1Y 5Y Max
None
1.630
1.231
0.832
0.432
0.033
+1,107.55%
+811.81%
+516.06%
+220.32%
-75.42%
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01/04/2021
02/01
MACD(12,26,9) MACD:0.28 Signal:0.19 Histogram:0.10
0.257
0.151
Quotes
News
Comments
Analysis
Press Re

Walkable Auckland: Enhancing Physical and Psychological Well-being through Urban Data Analytics

Our research project utilises anonymised geolocation data to evaluate green/park accessibility in Auckland and examines how the green/park enhances urban planning and improves residents' physical and psychological health.

Walkable Auckland: Enhancing Physical and Psychological Well-being through Urban Data Analytics addresses the urgent need for sustainable urban development in response to climate change and health disparities exacerbated by inadequate green space in Auckland. Utilising anonymised mobile geolocation data, our team is developing innovative metrics to assess the accessibility and utilisation of urban parks. This pilot study seeks to understand how park access correlates with physical and psychological health outcomes across different communities.

We will integrate these metrics with health data from the New Zealand Health Survey in the Integrated Data Infrastructure (IDI) to explore the relationship between park proximity and health issues such as obesity and heart disease. Similarly, we will examine the impact of park usage on mental health by analysing data from the Kessler Psychological Distress Scale. Our findings aim to demonstrate the tangible benefits of improved access to green spaces, suggesting that enhanced park accessibility can mitigate symptoms of depression and anxiety.

This research will provide valuable insights that can inform urban design and planning, promoting more equitable green spaces and a healthier lifestyle in Auckland. By engaging with stakeholders like the Auckland Council and leveraging a transdisciplinary approach, we ensure a comprehensive strategy for urban transformation.

William Cheung
Edward Yiu
I-Ting Chuang
Katarzyna Sila-Nowicka

Project open until: December 2026

Fields of research: Economics; Health sciences; Applied economics; Human geography and environmental geoscience; Urban and regional economics; Recreation, leisure and tourism geography; Public health; Environmental health

The Impacts of Housing Affordability and Anticipated Housing Pathway on Young People's Mental Stress

This study aims to examine the impacts of housing affordability stress and socio-demographic factors on housing pathway anticipation and mental health of young people in New Zealand.

House price escalation in recent decades has rendered homeownership unaffordable to many young people. Understanding how housing affordability could affect housing pathway anticipation and its impacts on young people's mental stress is crucial for governments to formulate housing policies. Both quantitative and qualitative approaches will be adopted. The quantitative approach involves applying regression analyses on the IDI datasets from StatsNZ. The qualitative approach involves a survey with young people in New Zealand to understand their housing pathway anticipation and mental stress. Structural equation modelling will be applied.

Edward Yiu
William Cheung

Project open until: December 2025

Fields of research: Economics; Psychology; Applied economics; Health economics; Social and Personality Psychology,

Education

Leadership, Learning and Change

Study of practices that support effective leadership, professional learning and organisational change.

Capacity to work in a range of sectors e.g. education, health, business.

Research focusses on how to bring about change for improvement in organisations.

Qualitative and mixed methods approaches can be employed

Data collection for study may take place in New Zealand or in another country

Deidre Le Fevre

Project open until: December 2026

Fields of research: Education; Curriculum and pedagogy; Education policy, sociology and philosophy; Education systems; Specialist studies in education; Other education

Exploring the Impact of Technological Innovations on Assessment Practices Within Large-Scale Introductory Statistics Courses

The project aims to identify and explain how the design and implementation of technological innovations has enhanced assessment practices within the context of large-scale introductory statistics courses.

There is limited research that addresses the assessment challenges that large-scale introductory statistics courses face, in particular with respect to the use of open book assessment and flexible assessment approaches. Our proposed research aims to identify and explain how the design and implementation of our technological innovations has enhanced assessment practices within the context of large-scale introductory statistics courses. For example, although there are a range of computational tools for creating question banks and deploying them to assessment platforms, there is minimal research that evaluates whether the multiple versions of the "same" question are effective and equitably assess students' conceptual thinking and reasoning. Our research will also explore the large-scale marking of short answer questions and how computational approaches and marking applications/tools can help human graders to organise similar answers for batch grading and informing pedagogical decisions. To inform the development of further technological innovations, such as automated formative assessment feedback for student writing, analysing the writ en responses will help us understand how the use and design of writing frames may impact the statistical communications produced by students.

Anna Fergusson
Stephanie Budget

Fields of research: Education; Curriculum and pedagogy; Mathematics and numeracy curriculum and pedagogy; Science, technology and engineering curriculum and pedagogy

Using Disability Studies in Education to Develop Inclusive Pedagogies and Inclusive Schools

This project aims to enhance equity within mathematics teaching (at primary and secondary schools) by using inclusive and strength based approaches, including narrative assessment, teacher inquiry, and UDL.

This project draws on the work of the team in inclusive and strengths based narrative assessment (primary and secondary schools), teacher inquiry to enhance equity and using inclusive pedagogies (including UDL) in primary maths teaching. We seek applicants who will be able to work alongside educators (school leaders and teachers), exploring and interrogating shifts in understandings, relationships and practices that underpin inclusive pedagogies. The findings of the project have the potential to shape inclusive ITE practices and to inform policy regarding curriculum decision making and support for educators and schools who aspire to be more inclusive.

Lisa Darragh
Missy Morton
Jude MacArthur
Fiona Ell

Fields of research: Education; Curriculum and pedagogy; Specialist studies in education; Education systems; Mathematics and numeracy curriculum and pedagogy; Inclusive education; Teacher education and professional development of educators

Global Childhoods: Early Years and Children's Futures

Explore the impact of early childhood experiences on future outcomes in a global context. This research examines diverse childhoods, aiming to inform policies shaping children's futures worldwide.

This research opportunity delves into the multifaceted experiences of early childhood across diverse global contexts. The project seeks to understand how early years shape lifelong outcomes, considering cultural, social, economic, and political influences. The research emphasizes the importance of transdisciplinary approaches, bringing together insights from education, sociology, anthropology, psychology, and public policy to holistically explore children's early experiences.

A key interest lies in examining how different societies construct childhood and the implications these constructions have on children's futures. The project encourages the use of a wide range of research methods, including qualitative, quantitative, and mixed-methods approaches. Ethnography, longitudinal studies, participatory action research, and comparative analysis are particularly valued for their ability to capture the complexities of childhoods in varying contexts.

By integrating perspectives from multiple disciplines and employing diverse methodologies, the research aims to generate comprehensive insights that can inform policies and practices globally. The ultimate goal is to contribute to the creation of equitable, inclusive, and supportive environments that foster positive outcomes for children worldwide, addressing both local and global challenges in the process. This research offers a unique opportunity to make a meaningful impact on the future of children around the globe.

Centre for Global Childhoods

Marek Tesar
Kiri Gould
Angel Chan
Andrew Madjar

Fields of research: Education; Other Education; Other education not elsewhere classified

Rural Education

PhD candidates interested in critical engagement with the unique yet diverse complexities of rurality and rural education.

Proposed studies may be conducted in any global context with those set in Aotearoa New Zealand and the Asia Pacific region particularly welcome. Studies aligned with the following topics are highly valued:

Rural schools and communities:

- Indigenous, Māori and Pacific contexts
- School-community partnerships
- Rural identity and capitals

Teaching and learning in rural contexts:

- Equity focused teacher education and educational leadership
- Access to educational learning opportunities, and student achievement
- Curriculum studies (e.g. maths)
- Diverse knowledges

Advancing justice and knowledge in rural education:

- Place-based and culturally relevant pedagogies
- Spatial justice across rural geographical contexts
- Diversity and inclusion (i.e. disability, ethnicity, class, gender etc.) across local, regional, national and global contexts

The aim of this call for PhD research projects is to advance critical rural education knowledge and expertise that will benefit rural students, educators and the wider communities they serve.

**rural is a complex concept: here rural / rurality refers to the experiences, perspectives and knowledges of peoples beyond major metropolitan contexts who identify as rural or its synonyms*

Jennifer Tatebe

Project open until: September 2025

Fields of research: Education; Other Education; Specialist studies in education; Education systems; Education policy, sociology; Curriculum and pedagogy and philosophy; Sociology of education; Education policy; Teacher education and professional development of educators; Mathematics and numeracy curriculum and pedagogy; Inclusive education; Special education and disability

Dance Education

International dance education pedagogy and curriculum development within school and community contexts

The project aims to deepen research into dance education and community dance practices around the world. Through qualitative research that values narratives and constructivist theories, the research gathers stories and nuanced insights into diverse practices, theories and issues.

Ralph McKay Buck

Project open until: February 2026

Fields of research: Education; Creative arts and writing; Curriculum and pedagogy; Creative arts, media and communication curriculum and pedagogy; Performing arts; Dance and dance studies

Young People's Digital Resilience

Interventions with digital tools to increase young people's resilience in digital worlds.
Focus areas: (a) online media and information literacy, or (b) digital citizenship (e.g. skills of self-regulation and empathy).

The aim is for educational sciences to contribute to developing and testing instructional designs with digital tools (including through gamification) which can build young people's resilience in digital worlds (see links to reports below). A Digital Interventions Group associated with Te Pūtahi | Woolf Fisher Research Centre (see links below) has developed and tested protypes of digital instructional designs for argumentation and information and media literacy (see below). The project would continue to research resilience in two areas: (a) Digital Citizenship skills (online skills such as self-regulation, perspective taking, and being empathetic); and (b) Media and Information Literacy (making judgements about the reliability, accuracy, believability, and usefulness of information). The educational sciences needed includes design-based research in schools to test effectiveness and includes research with Te Ao Māori and Mātauranga Māori perspectives.

He Uru Kahikatea - Building young people's resilience through media and information literacy and digital citizenship skills
Developing in Digital Worlds – Te Whakawhanake i roto i te Ao Matihiko

Stuart McNaughton

Project open until: July 2025

Fields of research: Education; Psychology; Curriculum and pedagogy; Educational technology and computing; Applied and developmental psychology; Educational psychology

Educational Leadership

We are interested in those with research projects concerned with improving educational leadership. We are particularly interested in studies focused on either leadership practices in educational settings, and/or approaches to leadership learning.

Potential topic areas include:

- Leadership Practice: Leadership of curriculum, collaboration, problems of practice or policy; intra- or inter-personal, organisational or system leadership.
- Leadership Learning: as it occurs online or in-person.
- Leadership for equity and inclusion

We welcome proposals for studies focused on success of leadership/leadership learning for those who have been under-served in educational systems. We aim to cultivate a network of educational leadership scholars whose work makes a difference for all the children, young people and educational communities they serve.

Claire Sinnema
Deidre Le Fevre

Fields of research: Education; Psychology; Specialist studies in education; Educational administration, management and leadership; Social and personality psychology; Social psychology

Engineering

Figure 6.11: RapidMiner Process to Filter Clean and Unclean Data for Further Analysis

Enabling Electrification of Industry through Flexibilization

This project will radically alter the operating and control principles of process plants to enable them to utilize cheap curtained electricity.

Economic and social pressures on industry are prioritizing the rapid decarbonization of both process heat and feedstock. Electrification is a suitable solution to these issues, but the cost and variability of electricity delivered through the grid are currently barriers. If process plants could alter their throughput dynamically, the lowest electricity prices could be accessed, making decarbonization possible.

In this project, we aim to develop new alternative operational strategies that will enable energy-intensive industries to achieve this flexibility. We are particularly interested in ammonia and methanol production, but students with experience and passion for other industries are also welcome. This work is largely modeling-based, and as such, any experience with process simulators and especially Python or Julia would be beneficial.

Industrial Information and Control Centre
Ahuora Centre for Smart Energy Systems

Brent Young
Isaac Severinsen

Fields of research: Engineering; Chemical engineering design; Chemical engineering design

Examining First and Last Mile Journeys of Public Transport from an Equity, Income and Gender Lens

The focus of this study is to investigate the role of integrated systems in assisting intergenerational equity.

In many cities, the urban sprawl is caused by low-density suburban residences located at the fringes. Low income households commonly occupy the suburban fringes. Public transport services to these suburban fringes are commonly low quality and poorly connected to the main network. A social exclusion approach to transport planning identifies the role of transport, land use planning and service delivery decisions to reduce disadvantage by some groups of the population (the transport disadvantaged). Certain groups of the population can remain in the poverty cycle for generations. This issue effects women in particular.

The study will investigate how integrated public transport systems can assist in reducing intergenerational inequity. Integrated systems can allow for more accessibility to employment opportunities. However, certain barriers can restrict the use of the systems. The findings of this study are expected to contribute significantly towards a bet er understand of equity frameworks and their applications to integrated systems. Data can be collected from the student's hometown.

Subeh Chowdhury
Timothy Welch

Fields of research: Engineering; Built environment and design; Human society

Real-time Gastrointestinal Positioning System (GPS)

This project will develop a magnetic tracking-based system for real-time guidance of catheter insertion into the gastrointestinal tract, harnessing state-of-the-art sensor technologies and machine learning techniques.

When gut function is impaired, nutritional support and diagnostic interventions often require the insertion of catheters, typically performed without visual guidance. This presents numerous risks, including death resulting from misplacement. Therefore, there is a clinical need for a new and reliable technology to guide and confirm catheter placement in real-time.

Magnetic tracking-based applications are used in a variety of fields such as control systems, home-security devices, computer/video games, and medical applications. A similar approach would allow tracking the location of catheters within the body and providing real-time guidance and confirmation of the catheter placement.

This project will develop a magnetic tracking-based 'GPS system' for the gut, employing state-of-the-art technology and optimisation and machine learning techniques for efficient, reliable, and accurate confirmation, enhancing the safety of procedures. This new technology will be low-cost and easy-to-use, allowing procedures to be performed at the bedside.

Required qualifications:

- Strong foundation and keen interest in electronics, instrumentation, and circuitry as well as machine learning techniques.
- Thorough comprehension of electromagnetic fields and their applications.
- Working knowledge of MATLAB, Python, and C programming.
- Familiarity with computer-aided design (CAD), optimisation techniques, and mobile app development.

Recep Avci
Leo Cheng

Project open until: December 2027

Fields of research: Engineering; Biomedical engineering; Biomedical instrumentation

Anatomically-Informed Gastric Source Imaging

This project will develop a novel anatomically-informed gastric source imaging technique to characterise the gastric electrical activities from non-invasive recordings, harnessing the state-of-the-art optimisation and machine learning techniques.

Digestion is co-ordinated by bioelectric activities. Abnormal electrical activity has been linked with motility disorders in the gut. Electrogastrogram (EGG) and Magnetogastrogram (MGG) are two techniques to non-invasively measure gastric electrical activities. They can be used to develop clinical biomarkers to diagnose motility disorders. However, characterisation of electrical activity using EGG/MGG is currently challenging because source models are not well defined and the impact of anatomical variation is not well understood.

We have recently developed a novel electro-anatomical mapping system to spatially co-register subject-specific anatomical models with electrical mapping of the stomach and EGG/MGG measurements, which helps us to bet er understand the impact of anatomical details in the recorded non-invasive fields. This project will use our electro-anatomical mapping system and develop a novel gastric source imaging technique to characterise the gastric electrical activities from non-invasive recordings, where anatomical information will be used to constrain the solution space.

Preferred Skills:

- No background knowledge of physiology or anatomy is required, but ideal candidates should have an interest in electrophysiology and mathematical modelling.
- Familiarity with optimisation and machine learning techniques is preferred.
-Working knowledge of MATLAB and Python is needed.

Electroanatomical mapping of the stomach with simultaneous biomagnetic measurements

Recep Avci
Leo Cheng

Project open until: December 2027

Fields of research: Engineering; Biomedical engineering; Computational physiology

Predicting Cardiac Arrhythmic Susceptibility Using Energy-Based Models and Physics-Informed Machine Learning

We aim to enhance cardiac arrhythmic risk predictions by integrating energy-based models with physics-informed machine learning, improving accuracy and interpretability while uncovering physiological mechanisms for reliable clinical application.

Cardiac arrhythmias are a major global health issue, and often occur unexpectedly. Around 20% of mortalities have sudden cardiac death from arrhythmia as the first symptom. Accurate early prediction of arrhythmic risk is challenging. Advances in data science and machine learning (ML) have led to models that classify cardiac rhythms and predict arrhythmias by analysing large clinical datasets, such as electrocardiograms (ECGs) and heart rate variability (HRV) signals. However, existing ML models often struggle with variability between patients and institutions and lack interpretability, making them less useful for clinical practice. To address this, we propose integrating energy-based bond-graph models of the physiological systems with physics-informed machine learning to both predict arrhythmia onset and provide insights into the underlying physiological mechanisms. This approach aims to develop new models that are robust, verifiable and with interpretable parameters. These models will bridge the gap between data analysis and clinical application.

bioRxiv

Weiwei Ai

Fields of research: Engineering; Biomedical engineering; Computational physiology

Modelling the Human Kidney Function

The aim of this project is to develop models for renin and angiotensin II release under normal physiological conditions and ANS innervation to the kidney, based on bond graph model.

This project is focused on developing a biophysically detailed model of the human kidney as part of the VITAL project, a collaborative effort between several European research groups and the Auckland Bioengeering Institute, which aims to deliver a virtual human twin for individualised optimisation of medical or surgical therapy for certain cardiovascular disorders such as hypertension.

We are looking for talented engineers and scientists to join our motivated team working on this exciting project. Current projects span the modelling spectrum from single proteins through to the whole kidney. Specifically, the project involves:

- The development of several Functional Cell Units (FCU) that deal with specific mechanisms along the nephron. Each of these FCUs will be built from bond graph models of the relevant proteins.
- The development of a 3D kidney scaffold that can be used to investigate spatial effects such as diffusion lengths and fluid volumes, and the relationship with the vascular system.
- The development of Functional Tissue Unit models of both cortical and medullary nephrons that will establish the link between subcellular models and the whole organ model.

The outcome of this project is crucial in understanding the role of the kidneys in cardiovascular disorders and developing a fully functional digital twin.

David Nickerson
Chang-Joon Lee
Peter Hunter

Project open until: December 2025

Fields of research: Engineering; Biomedical engineering; Computational physiology

Biofluid Mechanics and Biotransport

We have an active research group with opportunities for students in many areas of computational and experimental bioengineering related to human health.

We are using CT and MRI imaging data to develop computational models of aortic aneurysms, airway narrowing and cerebral blood flow for diagnosis, prediction and planning treatment. These projects involve close collaborations with local and international clinicians and the use of computational fluid mechanics, computational radiomics, 3D printing and machine learning.

Vinod Suresh

Fields of research: Engineering; Biomedical engineering; Fluid mechanics and thermal engineering; Bio-fluids; Biomedical fluid mechanics; Computational methods in fluid flow, heat and mass transfer (incl. computational fluid dynamics); Experimental methods in fluid flow, heat and mass transfer; Microfluidics and nanofluidics; Chemical engineering

Addressing Energy and Environmental Challenges with Membrane Technology

Research in membrane separation technology focuses on water treatment, food processing, or resource recovery, covering topics like fouling mitigation, ion-selective membranes, emerging processes, non-invasive fouling monitoring, or hybrid systems.

Membrane-based separation technology is gaining popularity due to its reputation as a clean technology, energy-efficient solution with a small footprint, and the ability to deliver superior product quality. Various projects are available in the area of membrane filtration technology for water/wastewater treatment, food processing, and resource recovery applications. Key areas of research include the development of novel strategies to mitigate membrane fouling, the fabrication of ion-selective membranes, the exploration of emerging membrane separation processes, non-invasive techniques for membrane fouling monitoring, and the design of hybrid membrane systems, such as integrated membrane systems with bioreactors, 3D printing technology, or renewable energy sources.

Filicia Wicaksana

Fields of research: Engineering; Chemical engineering; Separation technologies

Protect the Coastal Communities in the Pacific Region Against Climate Change Impact

This project will develop a framework to protect the coastal communities in the Pacific Region from climate change impacts, focusing on the effects of cyclones, flooding and sea-level rise.

The Pacific region is continuing to face the increasing impact of climate change. The study will focus on developing a framework based on modelling to protect the coastal communities. The framework will provide the adaptation strategies. How these strategies are implemented in the communities is also vital for the resilience and sustainability of the coastal communities.

Kilisimasi (Kris) Latu

Project open until: December 2025

Fields of research: Engineering; Civil engineering; Water resources engineering

Functional Recovery of Buildings and Resilience

This project aims to establish models that can be used by engineers or policy makers in predicting damage and recovery of buildings after a major earthquake event.

This research project requires a student with a civil engineering background who is keen to work on seismic resilience related areas.

QuakeCoRE

Alice Chang-Richards
Geoff Rodgers

Fields of research: Engineering; Civil engineering; Architectural engineering

Research on Soil Liquefaction During Earthquakes and Associated Phenomena

My research group has been investigating various aspects of soil liquefaction, from the nature of the hazard to its assessment and mitigation, as well as its impact to the built environment.

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.

Rolando Orense

Fields of research: Engineering; Civil engineering; Civil geotechnical engineering; Earthquake engineering

The Seismic out-of-Plane Behaviour of Unreinforced Masonry Structures

This project investigates analytically and numerically the out-of-plane response of masonry structures when subjected to earthquake loads.

During an earthquake, masonry walls, due to the weak connectivity with the side walls, formulate block-based collapse mechanisms and exhibit out-of-plane (OOP) rocking motion that can lead to the complete collapse of the structure. OOP behaviour is influenced by various factors, such as masonry quality, geometry, axial loads, openings, seismic signal, boundary conditions, and the presence of strengthening devices. The developed collapse mechanisms have been well-documented in the literature. However, only a few of those have been investigated.

This project examines the dynamic behaviour of masonry walls which are prone to OOP collapse from an analytical and numerical perspective. Experimental validation can also be part of the project, taking advantage of the state-of-the-art lab facilities of the University of Auckland.

Anastasios Giouvanidis

Funding: China

Fields of research: Engineering; Civil engineering; Earthquake engineering

Seismic Resilience through an Innovative Multi-Segment Rocking Bridge Column

This project investigates the potential of a novel multi-segment rocking bridge column configuration as a seismic-resistant paradigm for bridge design in high seismicity areas.

Rocking is considered a non-traditional seismic isolation technique that activates the rotational inertia of the structure to offer enhanced seismic stability. New Zealand is one of the countries that hosts many seismic-resistant rocking bridges.

This project investigates numerically and experimentally the seismic resilience of a novel multi-segment rocking column configuration as a seismic-resistant paradigm for bridge design in high seismicity areas. The proposed rocking column consists of multiple concrete segments, energy dissipation devices, and a central post-tensioning tendon for enhanced re-centring capacity. Advanced numerical models will simulate the seismic behaviour of the examined rocking column, while shake table tests, conducted in the state-of-the-art lab facilities of the University of Auckland, will offer further insights and validation of the proposed bridge column configuration.

Anastasios Giouvanidis

Funding: China

Fields of research: Engineering; Civil engineering; Earthquake engineering

Seismic Structure-Soil-Structure Interaction through Numerical and Analytical Investigations

This project investigates the complex interaction between a cluster of structures and the surrounding soil during earthquakes.

Structures, such as bridges and buildings, are often designed as standalone, i.e. single structures without neighbours. However, in large metropolitan areas, a high density of buildings and bridges interacting with one another and with the surrounding soil is inevitable during earthquakes.

This project explores the interrelationship between a cluster of structures and the surrounding soil during earthquakes and at empts to further understand its influence on the seismic response of those structures. The project investigates this problem from a numerical and analytical perspective, formulating advanced numerical models and simplified analytical formulations with the aim to approximately capture the complex realistic seismic response. The benchmark seismic response will be provided by experimental tests conducted at the state-of-the-art lab facilities of the University of Auckland, which will complement this project and offer validation of certain modelling assumptions.

Anastasios Giouvanidis

Funding: China

Fields of research: Engineering; Civil engineering; Earthquake engineering

Quantifying the Resilience of Commercial Cladding and Facade Systems Following Earthquake Events

The weathertightness of building cladding and facade systems following earthquakes is uncertain around the world. Failure of such systems can drammatically compromise the functionality of a building after an earthquake. This work will resolve this uncertainty and establish a baseline for facade system performance to be used in loss analyses.

The performance of commercial cladding systems is understood on a product-to-product basis, but no data exists that can classify performance at a regional or national level. Lack of this data makes it difficult to understand the contribution of cladding to financial losses following earthquakes. Furthermore, any limited data that is available is generally focused on structural performance whereas in a changing global climate where extreme storm events are expected to increase in frequency, it is important to also consider weathertightness performance. In this study, a database of commercial cladding systems will be developed with a focus on medium to lightweight systems. The database will contain both structural and weathertightness performance characteristics. The data will be used to develop cladding fragility functions that can be used by engineers to identify robust systems for a given building type. The fragility functions will then be used to undertake loss estimation on various buildings given a range of earthquake demands. The proportion of losses at ributed to cladding will be quantified. The outcomes of this research will produce a valuable database of cladding performance and benchmark the financial risk (if any) that cladding poses to the New Zealand building stock. These outcomes will be useful to industry as a form of performance validation for existing cladding systems or a driver for improvement for future ones.

Alex Shegay

Fields of research: Engineering; Civil engineering; Earthquake engineering; Architectural engineering

Investigation of Effective and Cost-Efficient Building Retrofit Strategies Using Modern Technologies

This project will use cost-benefit analysis and principles of structural engineering to identify cost-effective retrofit methodologies to enable rapid uptake of retrofit in cities in urgent need of improvement of building seismic capacity.

In 2022, major updates to the New Zealand seismic hazard model resulted in significantly increased expected earthquake intensities around the country (e.g., Wellington). This underscores the need to retrofit a considerable number of buildings that may no longer meet building design standards. A notable gap in New Zealand's capabilities is the absence of a standardized technical guideline for widescale seismic retrofits. This project aims to identify cost-effective retrofit methods and formulate recommendations for a New Zealand retrofit guideline. Cost-benefit analysis will be the primary tool used in this study to evaluate various retrofit strategies to establish a framework and methodology tailored to New Zealand's needs.

Alex Shegay

Fields of research: Engineering; Civil engineering; Earthquake engineering; Structural engineering

Investigate the Energy Sustainability of Samoa

Samoa has invested in different energy sources, but which is the most sustainable and reflects a good investment?

Energy sustainability is about finding the balance between a growing economy, the need for environmental protection and social responsibilities to provide an improved quality of life for current and future generations. Samoa, with limited land mass and surrounded by oceans, needs to determine the best energy sources and how they can be used in light of a growing energy demand. Renewable resources such as sunlight, wind, waves and biomass provide sustainable energy. This research aims to first identify the energy capabilities of the energy sources, second integrate the energy sources and identify the investment strategies for energy sustainability.

Kilisimasi (Kris) Latu

Project open until: July 2025

Fields of research: Engineering; Civil engineering; Water resources engineering

Comparative Analysis of Lifetime Costs: Base Isolated Buildings vs. Conventional Buildings

This research aims to address the challenge of low base isolation adoption by investigating its long-term economic viability and benefits. The research will focus on performance at ultimate limit state and explore the use of dampers to address concerns regarding large moat displacements.

The project consists of four key tasks. First, a comprehensive literature review will explore the state-of-the-art in base isolation modelling techniques, including moat pounding effects, isolator failure modes, and commercial damping products. Second, building models will be developed in OpenSees to simulate base-isolated and conventional buildings, incorporating findings from the literature review. Parametric studies will investigate the impact of different damping techniques, such as U-shape steel yielding dampers and viscous dampers, on building performance. Third, FEMA P-58 analysis will evaluate the direct monetary losses for both building types under various earthquake scenarios. Both structural and non-structural components will be considered in the cost analysis. Finally, a holistic economic assessment will consider additional economic losses due to building downtime, providing a comprehensive understanding of the building lifetime cost.

Alex Shegay

Fields of research: Engineering; Civil engineering; Earthquake engineering; Structural engineering

Towards Māori-Centric Generative AI Inspired by Te Tiriti o Waitangi Values

The key technical objectives of this proposal are: (i) To develop a novel methodology of policy mining such that the policies when enforced ensure that the cultural identity of the user is respected, and (ii) To develop an approach for run-time enforcement of the mined policies, which are further refined using co-design, to be used alongside any LLM, so as to always act using five Māori principles, when interacting with a user, either Māori or otherwise.

With the advent of AI in all sectors, there is a need for assessing the impact of this life changing technology on marginalised indigenous communities such as Māori. Hence, there is a need for developing a Māori-centric approach to AI. In this project, our focus will be on developing a runtime enforcer for existing Large Language Models (LLMs) to ensure their human interactions adhere to Māori principles. The overall methodology will be guided by co-design, led by our Faculty's Kaiārahi (Māori counsellor).

We will adopt a recent approach to AI founded on five different Māori values. We will prompt Gemini (or similar open LLMs) to develop two distinct models: one that is Māori-centric and follows these values, and an adversarial model that opposes these values. A neutral LLM (without any prompting) will engage the above two LLMs in automatic conversations, using mutation testing-based prompts. We will then use these interactions to mine a set of policies. These policies will be used to generate an enforcer, which can interface with any LLM. The enforcer will ensure that the real interactions of users with the enforced LLM always respect the principles of Māori cultural sensitivity. The overall methodology, including the key aspect of policy mining, will be validated by a Māori team. Our project is thus strongly aligned with SDG 10, Google's AI-ethics principles, Māori data sovereignty principles, and may form the basis for future ethical AI for and by indigenous people.

Partha Roop
Valerio Terragni
Jayden Houghton

Funding: Scholarship from project; All Scholarships

Project open until: December 2030

Fields of research: Engineering; Electrical engineering; Electrical engineering not elsewhere classified; Electronics, sensors and digital hardware; Digital electronic devices

High-Frequency Magnetics for Future Power Electronics

Research project on high-frequency magnetics for densification of power electronics.

Electricity generated from power plants or renewable energy sources must be converted using power electronics for electrical devices. This conversion process is carried out by power electronics systems that are ubiquitous in a wide range of applications, from mobile phones to substations. As electronics become increasingly sophisticated and intertwined in all facets of society, there is a demand for power electronics to process more power, but with a smaller form factor. Magnetic components are a key challenge in improving this power density of power electronics systems as the magnetic components tend to be the heaviest and bulkiest part of a power electronics circuit. In the last few decades, magnetic components have not seen drastic improvements in performance and miniaturisation similar to what is seen in switching devices and capacitors.

This doctoral research project provides an opportunity to research high-frequency magnetics for densification of power electronics. The PhD candidate will be part of a multi-disciplinary research team investigating new research avenues to improve magnetics for future power electronics.

Seho Kim
Grant Covic

Fields of research: Engineering; Electrical engineering; Engineering electromagnetics

Development of Natural Fibre Reinforced Hollow Cores Sandwich Panel and Evaluation of Functional Properties

The project aims to design and manufacture a high-performance and sustainable composite sandwich panels utilising natural fibres with potential applications in the civil and aerospace sectors.

The aerospace and construction industries are confronted with significant challenges concerning the fire behavior of polymeric materials. Synthetic polymers exhibit high flammability and pose substantial health risks due to their non-degradability and toxicity. Additionally, off-cuts generated during the manufacturing of polymeric products, along with materials at the end of their life cycle, are predominantly disposed of in landfills, leading to severe environmental impacts. Consequently, there is a compelling drive to replace these polymers with bio-based alternatives for the production of composite panels.

This project aims to develop a new generation of innovative composite materials utilising natural fibres, such as flax and wool, with extensive potential applications in the civil and transportation sectors. The project will investigate, model, and develop sandwich structures reinforced with natural fibre hollow cores. These sandwich panels, designed for use in buildings or aircraft interiors, will significantly enhance flame retardant and sound-absorbing capabilities, leveraging the inherent properties of the natural fibres to provide fire protection and noise isolation. Additionally, the project will explore the specific hollow core structure of the natural fibre composite panels to improve strength and toughness, assessing their impact resistance using a drop-weight test machine.

Nam Kyeun Kim
Tom Allen

Funding: China, Indonesia

Project open until: November 2025

Fields of research: Engineering; Materials engineering; Manufacturing engineering; Composite and hybrid materials, Manufacturing processes and technologies (excl. textiles)

Thermal Metamaterials with Advanced Heat Transfer Properties

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.

Artificially structured materials have received significant interest in recent years. These metamaterials, in particular, have been successfully exploited for control of sound and vibration transmission. The phenomenon of heat transfer has always been of great practical importance and recently there have been at empts to develop and utilize metamaterials for manipulating, controlling and processing the flow of heat. It has been shown that 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 the 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.

Vladislav Sorokin

Project open until: July 2026

Fields of research: Engineering; Mechanical engineering; Numerical modelling and mechanical characterisation

Tidal Energy for Powering Marine Aquaculture Farms

This project aims 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.

Marine farming of aquaculture is one of the fastest growing industries in New Zealand and globally and requires a resilient supply of clean and cheap electrical energy. Tidal energy conversion has great potential for supplying the current and future energy needs of the marine farming industry and provides an opportunity to grow the global economy. Previously, there have been at empts to use solar energy for aquafarming needs, however, the cost-effectiveness has been inconsistent and the solar panels required 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 1KWat) 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

Vladislav Sorokin

Project open until: July 2026

Fields of research: Engineering; Mechanical engineering; Energy generation, conversion and storage (excl. chemical and electrical)

Sound and Vibration Attenuation in Structures with Periodically Changing Properties

This project aims to reveal sound and vibration attenuation characteristics of periodic structures, e.g. building walls, with stiffness, mass and damping properties variations.

Analysis of elastic wave propagation in periodic structures is a popular research topic, and such structures are extensively used for vibration at enuation purposes, e.g., to secure certain parts of technological devices or constructions such as building walls from vibrations. This is accomplished by employing the characteristic feature of periodic structures, i.e., the presence of frequency bandgaps, frequency ranges in which travelling waves at enuate. The frequency bandgaps occur due to two different physical mechanisms, 1) Bragg scat ering, related to multiple wave scat ering leading to destructive wave interference, 2) Local resonance, when the vibrational energy of the hosting structure is transferred into vibrations of resonant at achments, such as masses on springs. Examples of periodic structures featuring Bragg scat ering bandgaps include beams and rods with periodically varying cross-sections and plates with varying thickness. The present project aims to reveal the effects of spatially varying damping on wave propagation in periodic structures and Bragg scat ering bandgaps. In particular, we aim to reveal whether periodic structures with properly arranged stiffness, mass and damping variations can outperform conventional periodic structures with only stiffness and mass variations. The project implies both theoretical and experimental studies. The method of varying amplitudes will be used for theoretical prediction of dispersion relations and Bragg scat ering bandgaps. The obtained results will be tested experimentally for a rod, beam or plate with periodically varying properties (cross-sectional area).

Vladislav Sorokin

Project open until: July 2026

Fields of research: Engineering; Mechanical engineering; Dynamics, vibration and vibration control

Security-Enhanced Machine Learning for Safety-Critical Applications

Development of hardware/software co-design framework to characterize the energy/power and performance overheards to mitigate the security vulnerabilities of safety-critical applications.

Intelligent embedded systems, essential parts in safety-critical applications, are required to satisfy performance and power/energy efficiency design constraints, in addition to achieving a high level of reliability and security. AI/ML have been extensively used for many applications such as computer vision, industrial automation and robotics, natural language processing and speech processing. However, to employ different exiting AI/ML algorithms and architectures for safety critical applications such as autonomous vehicles and medical devices, time-predictability and reliability of the target implementation platforms should be guaranteed. The aim of this research is to investigate hardware/software co-design of security-enhanced machine learning to characterize performance and energy consumption overheads due to security enhancement features which may affect the time-predictability requirements. As part of this research, deep learning neural network (DNN) heterogenous architecture will be developed and hardware accelerators will be implemented on an FPGA based platform. The FPGA development board provides high performance hard-core processors and several hundred thousand configurable logic elements to implement the required reconfigurable platform for the experiments. The target applications for this research are autonomous vehicles and robots, medical devices and industrial automation systems.

Morteza Biglari-Abhari

Fields of research: Engineering; Artificial intelligence; Cybersecurity and privacy; Machine learning; Hardware security

Cellular and Molecular Bioengineering

We have an active research group with opportunities for students in computational and experimental cell research.

We use cell culture models to investigate the function of epithelial cells in the lungs, intestines and salivary glands, in relation to nutrient absorption, vaping, tumours and radiation therapy. These projects involve a combination of experimental work and mathematical modelling in collaborations with mathematicians, clinicians and biologists. Applicants with a background in engineering, science or mathematics are encouraged to apply.

Vinod Suresh

Fields of research: Engineering; Biological Sciences; Biomedical engineering; Fluid mechanics and thermal engineering; Computational physiology, Mechanobiology; Biochemistry and cell biology

Multimodal Imaging to Quantify Gut Contractions

Develop a framework for simultaneous optical tracking and electrical mapping of the contractions in the gut.

Ordered electrical slow waves are critical for the co-ordination of mechanical contractions in the gut. Other factors that are believed to influence motility intensity and pat erns include: stretch, temperature, anesthesia and hormones. The influence of such parameters has not been systematically evaluated using electrical recordings combined with video mapping techniques. Multiple frameworks are available to track gut contractions both in vivo and in vitro. While each framework has its advantages and limitations, a unified framework will go a long way towards standardising videographic analysis of gut motility.

Aim 1: Develop an integrated framework for tracking motility of gastrointestinal motility.

Aim 2: Quantify the correlation between electrical activity and mechanical contractions in the stomach and small intestine.

Aim 3: Quantify the motility pat erns of in vitro multi-day organotypic cultures.

Leo Cheng
Peng Du

Funding: Scholarship from project

Project open until: July 2025

Fields of research: Engineering; Biomedical and Clinical Sciences; Biomedical engineering; Biomechanical engineering; Biomedical imaging; Medical physiology; Systems physiology

Investigating Epicardial Adipose Tissue Geometry and Shape: Unraveling Its Role on Atrial Fibrillation

This project uses deep learning to analyze epicardial adipose tissue geometry in atrial fibrillation, aiming to develop personalized ablation strategies based on patient-specific tissue characteristics.

Atrial Fibrillation (AF) is the most prevalent cardiac arrhythmia, leading to increased risks of stroke, heart failure, and other cardiovascular complications. Emerging evidence suggests that the geometry and shape of Epicardial Adipose Tissue (EAT) play a critical role in the development and persistence of AF. However, the exact mechanisms through which EAT geometry influences atrial function and AF onset remain poorly understood, limiting the effectiveness of current therapeutic approaches.

EAT is a unique fat depot located between the myocardium and the visceral pericardium. Its proximity to the heart's atrial chambers suggests a significant influence on atrial electrophysiology and structural integrity. Variations in the geometry and shape of EAT may contribute to atrial remodeling, a key factor in AF pathogenesis.

The aims of this PhD project are to:

1. Utilize deep learning to segment Epicardial Adipose Tissue (EAT) and the four cardiac chambers from large-scale CT data
2. Establish statistical shape models to study the geometry distribution of EAT
3. Conduct clinical studies to assess how variations in EAT geometry influence ablation outcomes and develop personalized ablation approaches based on patient-specific EAT characteristics

Desired skills: Ideal candidates will have a Master's or Bachelor's degree in Engineering/ Mathematics and will have programming skills. Experience in medical imaging or computational modeling will be beneficial.

Jichao Zhao
Fan Feng

Funding: Scholarship from project

Project open until: December 2027

Fields of research: Engineerlng; Biomedical and Clinical Sciences; Biomedical engineering; Biomedical imaging; Cardiovascular medicine and haematology; Cardiology (incl. cardiovascular diseases)

AI-Enhanced Identification of Ablation Targets for Improved Atrial Fibrillation Treatment

Atrial fibrillation treatment benefits from AI-enhanced methods to identify precise ablation targets, improving accuracy, reducing tissue damage, and increasing long-term success rates in patients unresponsive to medication.

Atrial fibrillation (AF) is the most common heart rhythm disorder and a significant cause of morbidity and mortality worldwide. For patients with poorly tolerated AF that is unresponsive to medication, ablation therapy has become a common treatment. This involves guiding a catheter through a vein to the atrial wall and applying heat or cold to disrupt the arrhythmia's drivers and restore normal rhythm. However, inaccurate ablation can damage healthy cardiac tissue and reduce viable muscle. The key challenge is precisely identifying the optimal ablation sites to restore rhythm while minimizing damage. Multi-electrode mapping catheters are used to detect atrial electrical activity and identify potential targets, but the chaotic nature of AF complicates beat-by-beat mapping. This highlights the need for faster and more accurate methods to identify ablation targets based on electrical activity recorded on the atrial endocardial surface, improving long-term success rates and reducing the need for repeat procedures.

The aims of this PhD project are to:

1. Use AI to enhance our wavelet-based signal processing approach for intracardiac electrograms pre-processing.
2. Evaluate a recent conventional approach of using the new time-averaged measures of regional phase heterogeneity to identify atrial drivers and ablation targets.
3. Develop and validate an AI approach to refine the identification and validation of ablation targets.

Desired skills: Ideal candidates will have a Masters or Bachelors Degree in Engineering, or related fields and have strong software development skills.

Jichao Zhao
Shu Meng

Funding: Scholarship from project

Project open until: December 2025

Fields of research: Engineerlng; Biomedical and Clinical Sciences; Biomedical engineering; Computational physiology; Cardiovascular medicine and haematology; Cardiology (incl. cardiovascular diseases

Spinal Neural Electrical Activity for Characterisation and Prognosis of Spinal Cord Injury

This project will establish a foundation for interpreting subdural spinal electrical recordings supporting the future potential to guide treatment and rehabilitation in patients with spinal cord injury.

This project will focus on establishing a foundation to interpret electrical recordings of the spinal cord and how these recordings change after spinal cord injury. Our wider research programme is developing treatments for spinal cord injury using electroceutical approaches where we generate electric fields within the spinal cord to stimulate regeneration of damaged axons. We have developed an ultrathin bioelectronic that is capable of generating electric fields within the spine, simultaneously recording the innate electrical activity generated from spinal neurons and axons. We are investigating the potential for spinal electrical recordings to inform treatment parameters through electrical characterisation of a spinal injury. In order to interpret the electrical activity that we record from the spine we need to understand how neuronal action potentials at different locations within the spine are recorded by our surface implant. This will be achieved using a finite element model approach to calculate how local field and action potential electric fields propagate through the spinal cord and are recorded by electrodes on the implant. These simulations will be linked to our in vivo models through histology to image axons within healthy and injured spinal cords. See Harland B, et al. A Subdural Bioelectronic Implant to Record Electrical Activity from the Spinal Cord in Freely Moving Rats. Advanced Science (2022),

Darren Svirskis
Brad Raos

Project open until: 2025

Fields of research: Engineering; Biomedical and Clinical Sciences; Biomedical engineering; Neural engineering; Neurosciences; Computational neuroscience (incl. mathematical neuroscience and theoretical neuroscience)

Energy-Based Modeling and System Analysis of Autonomic Imbalance in Cardiovascular Diseases

Autonomic imbalance, linked to cardiovascular diseases, is explored using an energy-based model to understand and address discrepancies in energy demand and supply, aiming for effective therapeutic targets.

Autonomic imbalance, characterized by elevated sympathetic activity and decreased parasympathetic tone, plays a crucial role in the pathophysiology of cardiovascular diseases and metabolic disorders such as hypertension, heart failure, ventricular arrhythmias, and diabetes. While extensive research has established statistical relationships and advanced our understanding, significant gaps remain in our knowledge of sympathetic and parasympathetic interactions and the causal factors driving progressive sympathoexcitation and parasympathetic dysfunction. The allostasis paradigm links these arousal pathologies to failures in adaptive optimal control.

Given that energy flow drives physiological function and defines adaptive capacity, we hypothesize that normal autonomic control seeks to minimize the system's energy expenditure. Autonomic imbalance, therefore, may arise from a mismatch between the system's energy demand and supply. To address this, we have developed an energy-based modeling framework to track energy storage, dissipation, and transduction across physiological processes. Our research aims to explore novel methods for systematically analyzing energetic activity and understanding the mechanisms underlying autonomic imbalance. The outcomes of this research have the potential to identify new therapeutic targets for restoring regulatory balance and effectively treating related diseases. We are seeking students with experience in computational modeling. Familiarity with control systems and biological physics would be added advantages.

Weiwei Ai
Kenneth Tran

Project open until: December 2030

Fields of research: Engineering; Biomedical and Clinical Sciences; Biomedical engineering; Control engineering, mechatronics and robotics; Computational physiology; Biomechatronics; Simulation, modelling, and programming of mechatronics systems; Medical physiology; Human biophysics

High-Performance Aqueous Rechargeable Batteries

This research project aims to develop novel electrode materials to enhance the performance of aqueous rechargeable batteries.

Electrochemical energy storage is a rapidly developing field with significant impact on decarbonising our energy sector. Current electrochemical energy storage technologies primarily rely on lead-acid, Ni-MH, and Li-ion bat eries, which face severe technical barriers in terms of energy density, cost, and sustainability.

Aqueous metal-air bat eries use oxygen from the air as one of the bat ery's main reactants. Due to their remarkably high energy density, aqueous metal-air bat eries have at racted significant at ention as a next-generation bat ery technology. The specific objectives of this project include:

1. Developing advanced electrode materials for aqueous rechargeable bat eries

2. Investigating the charge/discharge mechanisms and the reaction interfaces of these bat eries.

Shanghai Wei

Project open until: 2028

Fields of research: Engineering; Chemical Sciences, Chemical engineering; Materials engineering; Electrochemical energy storage and conversion; Composite and hybrid materials; Metals and alloy materials; Inorganic chemistry; Theoretical and computational chemistry, Electrochemistry; Reaction kinetics and dynamics; Computational chemistry

Interfacial Engineering for Next-Generation Rechargeable Batteries

This research project aims to understand the interfacial reaction mechanisms in aqueous rechargeable batteries.

Rechargeable bat eries play a critical role in transmitting and distributing electrical energy, especially with the introduction of electric vehicles over the last decade. However, the development of next-generation rechargeable bat eries—including aqueous bat eries, all-solid-state bat eries, and non-lithium bat eries—has been severely hindered by knowledge gaps related to solid-electrolyte interfaces.

In this project we will apply both ex-situ and in-situ characterisation methods to study the composition, morphology, and electronic and ionic properties of solid-electrolyte interfaces. We will then illustrate the formation and failure mechanisms of solid-electrolyte interphase layers. This proposed research could pave the way for developing high-performance and sustainable rechargeable bat eries.

Requirements: A background in electrochemistry, materials chemistry, or chemical and materials engineering. Applicants should be enthusiastic and interested in the energy storage field.

Shanghai Wei
Prof Tilo Söhnel

Funding: Scholarship from project

Fields of research: Engineering; Chemical Sciences; Chemical engineering; Materials engineering; Electrochemical energy storage and conversion; Composite and hybrid materials; Metals and alloy materials; Physical chemistry; Inorganic chemistry; Theoretical and computational chemistry; Electrochemistry; Reaction kinetics and dynamics; Computational chemistry

Improve Green Hydrogen Production Efficiency

In this project, a renewable energy generated electricity will be mimicked and used for green H2 production via water electrolysis, and power conditioning and materials design will be investigated to improve energy efficiency.

New Zealand has embarked on a mission to adopt hydrogen (H2) as a component in the national energy mix to meet the net-zero carbon emission goal by 2050. The NZ Ministry of Business, Innovation and Employment (MBIE) has recently released the potential NZ hydrogen economy scenarios, suggesting that the green hydrogen energy sector will meet 8% of NZ's energy demand by 2050. Water electrolysis has been one of the commercialised technologies for green hydrogen production. In this project, a renewable energy generated electricity will be mimicked and used for green H2 production via water electrolysis. A control algorithm will be integrated to the power control unit, and the performance of a water electrolyser will be monitored and analysed.

Jingjing Liu
Aaron Marshall
Seho Kim

Fields of research: Engineering; Chemical Sciences; Chemical Engineering; Materials Engineering; Electrical engineering; Electrochemical energy storage and conversion; Metals and alloy materials; Electronic instrumentation; Physical chemistry; Reaction kinetics and dynamics

Acoustic Analysis of Reed/Player/Mouthpiece Interaction in Single Reed Instruments

This study quantitatively analyzes reed/mouthpiece/player interactions in single reed instruments using numerical modeling and 3D printing, aiming to enhance sound quality and accessibility through innovative design and experimental validation.

The interaction between the mouthpiece, reed, and player is crucial in shaping the sound of single reed woodwind instruments. This study aims to quantitatively analyze these interactions to enhance the design and performance of mouthpieces and reeds. Traditional design methods often rely on anecdotal knowledge, leading to inconsistent results. This research will employ numerical modeling and experimental validation to investigate the effects of various design parameters on sound production.

Using an artificial blowing machine, we will achieve repeatable measurements, eliminating human variability. The study will also explore the impact of the vocal tract on sound, acknowledging that different players may require customized designs. Advances in 3D printing technology will facilitate the creation of mouthpieces with complex internal structures and synthetic reeds with controllable sound characteristics.

The research will involve subjective testing with both players and audiences to assess the perceived quality of the sound. The findings aim to make high-quality, custom mouthpieces and reeds more accessible. Expected outcomes include several journal publications and a deeper understanding of the reed/mouthpiece/player interaction.

Andrew Hall
George Dodd
Vladislav Sorokin

Fields of research: Engineering; Creative Arts and Writing; Mechanical engineering; Music; Music technology and recording

Natural Hazards Resilience: Built Environment Focus

A number of research opportunities will be emerging from 2025 in the area of natural hazards resilience of the built environment, with both a New Zealand and international focus.

There is a strong track record of natural hazards resilience research in New Zealand, with a number of large multi-disciplinary research programmes across multiple institutions. Within Civil Engineering, this has focussed on buildings, critical infrastructure and the interaction between these. A number of existing and emerging research programmes will be offering PhD funding from 2025. These will focus on various hazards, including earthquakes, tsunami, flooding, and climate change. They will explore various scales relative to the built environment, from components, to single facilities, to infrastructure networks and the interaction between these networks and the wider built environment.

Liam Wotherspoon

Funding: Scholarship from project

Fields of research: Engineering; Earth Sciences; Civil Engineering; Complex civil systems; Natural Hazards,

Wearable Sensors for the Lower Limb

Surgery after sports injury or recovery from stroke requires rehabilitation. The use of wearable sensors allows a more quantifiable method to monitor the progress. Sensors can also reduce the cost of physiotherapy visits. The use of wearable sensors that can be comfortably worn while the walking gait is analysed would greatly improve rehabilitation routines and reduce recovery time.

This research will involve:

1. The design and development of wearable sensors for the lower limb.
2. The implementation of electronics with the sensors and communication with smart phones.
3. Development of machine learning that is able to predict progress.
4. Development of an app and computer software that will collect the data from the sensors, process the data and provide prediction.

Kean Aw
Luke Hallum
Andrew McDaid

Funding: Scholarship from project

Project open until: December 2026

Fields of research: Engineering; Biomedical engineering; Rehabilitation engineering; Biomechanical engineering

Prediction of Long-Term Surgery Outcome through Mathematical Modelling of Bone Growth

Finite Element Analysis (FEA) is a mathematical representation of geometry, materials and forces to non-invasively understand the mechanical properties of bone. FEA models have been used to examine fracture risk in osteoporosis patients, fracture healing, bone development and bone remodeling. However, there have been minimal FEA models developed for pediatric bones. An understanding of bone morphology and mechanics during childhood and adolescence will inform mechanisms of bony deformation in musculoskeletal disorders and predict future complications from orthopedic surgical intervention. This work will create the cornerstone for novel in silico clinical decision-making tools for personalized interventions in children and adolescents.

One of the biggest unknowns for an orthopedic surgeon is how the bone will remodel after surgery. This long-term outcome can help in determining if the patient will consequently develop hip osteoarthritis or require further surgical intervention. Personalized FEA models are increasingly being used to measure bone healing and complement or replace traditional imaging outcome measures. However, the scarcity of pediatric imaging and experimental data to develop FEA models has limited progress in the field. Our extensive dataset of pediatric CT scans is the first of its kind but only includes cross-sectional data. A longitudinal approach is necessary to study bone growth and to build and validate computational bone growth models. The Tairāwhiti child well-being study is imaging children every year from the age of 7 through to 18 years of age to provide detailed information on growth and development and predict early signs of disease. Automatic image segmentation in the pelvis, femur and tibia bones from full body MRI sequences will be developed using nnUnets. From these bone segmentations, the doctoral candidate will build personalized FEA models based on a previously validated shape-density model. Subsequently, a mechanobiological growth simulation will be built based on the literature. The predicted bone growth simulation will be compared to subsequent MR images from the same child at one-year increments. Once the model has been developed and tested on a typically developed cohort, the student will validate the model on retrospective patient medical imaging of 1) pre-, 2) post-surgery and 3) before their revision surgery, adjusting the model to the time between the post-surgery and revision surgery examination.

Julie Choisne

Project open until: December 2026

Fields of research: Engineering; Biomedical engineering; Biomechanical engineering; Mechanobiology

A Novel Digital Twin of the Human Heart

In this project we will work on designing a personalised heart on a chip.

We have designed a heart on a chip for the validation of pacemakers jointly with the Auckland Bioengineering Institute (ABI). A video can be found at (ht ps://youtu.be/PW8j317ayvE). This HoC is designed using formal models of the cardiac conduction system, along with tools which transform these models into an embedded system, using hardware / software codesign. These models are based on generic models of the cardiac conduction system.

These models are parametric and have the potential for personalisation. In this project we will personalise these models by using data from wearable devices such as smart watches, equipped with ECG / PPG sensors. By collating data from such devices, we will develop approaches to personalise these models. To make HoC a digital twin, the model will continuously interact with a wearable and compare the generated ECG with that of the wearable. The parametrisation will be first static and subsequently dynamic and continuous until the two signals are within some small error threshold. Such a digital twin will be of immense value from the point of view of designing personalised pacemakers and other ICD devices, specific to a given human and will allow medical professionals to treat the disease condition more effectively. This work will be carried out jointly with some pacemaker companies and Mathworks (collaborative agreement is under discussion).

Heart on Chip Demo

Partha Roop
Mark Trew

Project open until: December 2027

Fields of research: Engineering; Biomedical engineering; Computational physiology; Electronics, sensors and digital hardware; Digital electronic devices

Decoding the Mechanisms Underlying Heart Disease

In this project you will further our understanding of heart disease and treatment strategies by developing novel bioinstrumentation and advanced computational models.

I am searching for students with an interest in computational modelling in the areas of cardiac physiology and energy metabolism. I have projects that 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 computational 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 advanced computational methods. 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.

Kenneth Tran

Fields of research: Engineering; Biomedical engineering; Computational physiology; Biomedical engineering; Biomedical instrumentation

Investigate Water Security for Remote Islands

This project investigates how the remote islands in the Pacific region are being affected by climate change and defines a framework to ensure water security.

Pacific Island countries are continuing to be affected by climate change. This research seeks to use future climate scenarios to determine the water security in the region and the adaptation needed. The threats to freshwater resources in the Pacific Countries have been a serious concern since the late 19th century. El Nino conditions influence freshwater lenses and increase salinity levels during dry seasons. Werner, Sharp et al. (2017) produced a comprehensive review of the fresh groundwater lenses (FGL) in the atolls and recommended key groundwater studies related to FGL in the region. There is a lack of country-specific climatic data to assess the sensitivity of freshwater resources to climate change and variability on atolls and other small low islands. Using multiple water resources in different seasons to meet consumptive and non-consumptive purposes is vital for the Pacific Countries. Water policies must be well informed by state-of-the-art approaches in water studies, but these types of studies are largely missing. Devlin, Smith et al. (2020) emphasised the region's lack of water quality studies. There is an urgent need for accessible water quality data and an improved understanding of the impacts of pollution to ensure sound environmental health and human well-being and support sustainable industries.

Kilisimasi (Kris) Latu

Funding: Scholarship from project

Fields of research: Engineering; Civil engineering; Water resources engineering

Smart Sewer System Modelling and Optimisation

Apply smart modelling (combining physics, data and AI tools) to analyse static and real-time data, identify high-risk areas and optimise maintenance and refurbishment programmes.

Sewer systems are critical for safe and healty urban environments. These systems are under increasing stress due to age-related pipe deterioration, stormwater ingress, changing rainfall pat erns and urban densification. This project will develop a smart model (combining physics, data and AI tools) that incorporates hydraulic modelling with data on the network, past failures, and CCTV inspection reports, as well as live rainfall, flow, level and smart sensor data to identify points at risk of failure, and optimise maintenance and refurbishment programmes.

Kobus van Zyl

Project open until: December 2025

Fields of research: Engineering; Civil Engineering; Infrastructure engineering and asset management; Civil Engineering; Water resources engineering

Behaviour of Leaks at Joints in Water Distribution Systems

Experimental and modelling study to investigate the pressure-flow behaviour of leaks at joints in water distribution systems.

Leakage from water distribution systems is a significant problem all over the world, particularly in light of limited water resources and the potential impact of climate change. Leaks are hydraulic orifices and thus their flow rates should be proportional to the square root of the water pressure. However, when pressure is lowered in real water distribution systems, it has been found that leakage is much more sensitive to pressure and is often a function of the pressure squared.

A key reason for this anomaly is that leak areas are not constant but vary linearly with pressure. Bet er understanding of the way that different types of leaks respond to pressure will allow engineers to simulate and manage leaks in pipe networks more accurately.

Past work on pressure-leakage behaviour has focussed on pipes, but there is a need to also understand the contribution of pipe joints to the observed network leakage response.

The aim of this project will be to investigate, model and experimentally test joint leaks in different pipe materials and diameters, and then develop models for predicting how joint leakage will affect network leakage under different conditions.

Kobus van Zyl

Project open until: December 2025

Fields of research: Engineering; Civil Engineering; Water resources engineering; Civil Engineering; Infrastructure engineering and asset management

Novel Autonomous Vehicle Design Paradigm: Combining Machine Learning with Formal Methods

Autonomous vehicles require high assurance safety and timing guarantees. They rely heavily on machine learning algorithms in their decision making. These algorithms, while being very smart and efficient, lack formal semantics, especially when several algorithms are composed into a single overall system. Moreover, the timing of the system may be non-deterministic, which is counterproductive for safety critical systems. In this project we seek to combine machine learning with formal methods to address these shortcomings. We expect to use machine learning to determine a set of suitable policies/properties, which will aid the formal analysis of the system. Both static and run-time verification techniques will be considered.

In this project, we will use conventional microsimulators and the recent Intel simulator, Carla, to develop a case study of autonomous driving. This case study will model both sensors, actuators and control algorithms. The developed models will combine AI models (say for pedestrian detection) and conventional control models (say for ACC or ABS). We will then develop approaches for systematic formal verification of these models followed by code generation.

Synchronous Neural Networks For Cyber-Physical Systems
Model Based Verification of Spiking Neural Networks in Cyber Physical Systems
IEEE Xplore

Partha Roop
Avinash Malik

Project open until: December 2028

Fields of research: Engineering; Electrical engineering; Electrical engineering not elsewhere classified; Electronics, sensors and digital hardware; Digital electronic devices

Development of a Smart Bolt Tension Indicator for the Optimised Sliding Hinge Joint

The objective is to develop a portable device to quickly and accurately measure the elastic bolt tension in a specialist connection at any time throughout the life of the building.

The Optimised Sliding Hinge Joint (OSHJ) is a specialist seismic resisting connection which is rigid under in-service operating conditions, becomes flexible during a severe earthquake then becomes rigid once the earthquake stops. The bolts are tightened into the elastic range only and are expected to remain in that condition before, during and after a severe earthquake. However, after an earthquake we need a device that can measure the installed bolt tension and transmit that wirelessly to a recording device. It needs to be portable, lightweight and have its own power supply. Such a device does not currently exist worldwide.

In 2023 a pair of final year undergraduate students undertook the first work on developing such a device. They came up with a slope measuring concept which works in principle, but were not able to get beyond the concept stage. This challenging project, involving a mix of mechanical and electronic research and development, is focussed on the development of a concept (which may or may not be the 2023 concept), turning that into a working prototype calibrating this for reading off installed bolt tension and validating its use in practice. There will be IP with this project.

Charles Clifton
Xun Xu

Funding: Scholarship from project

Project open until: March 2025

Fields of research: Engineering; Electronics, sensors and digital hardware; Manufacturing engineering; Electronics, sensors and digital hardware not elsewhere classified; Manufacturing engineering not elsewhere classified

Energy Harvesting

Energy harvesting can provide alternative energy source to power remotely located sensors or electronics. This energy could come freely from the environment that could be transduced into electrical energy.

To harvest energy efficiently from the environment, especially those that are in the mechanical form, requires the design of effecient mechanical structures/mechanism. Further the implementation of transduction technique requires careful consideration involving materials and electronics. This research will consider research in energy harvesting from ocean, wind, vibration and human motion using either electromagnetic, piezoelectric or triboelectric transduction.

Kean Aw
Lihua Tang
Vladislav Sorokin

Funding: Scholarship from project

Project open until: December 2026

Fields of research: Engineering; Mechanical engineering; Mechanical engineering not elsewhere classified; Materials engineering; Functional materials

Optimising the Operation of Shared Autonomous Vehicles (SAVs) Especially Electric SAVs

This research proposal focuses on optimizing the operation of shared autonomous vehicles (SAVs), particularly electric SAVs, to enhance efficiency, reduce emissions, and improve urban mobility and sustainability.

The project aims to optimize the operation of Shared Autonomous Vehicles (SAVs), particularly focusing on electric SAVs (e-SAVs), to enhance their efficiency, reduce emissions, and improve urban mobility. As urban areas face increasing congestion and environmental challenges, e-SAVs offer a promising solution by providing on-demand, shared transportation with reduced carbon footprints. However, optimizing their operations involves several complex factors, including dynamic routing, fleet management, bat ery life, charging infrastructure, and user demand pat erns.

This project will develop advanced algorithms incorporating real-time data analytics, machine learning, and optimization techniques to improve e-SAV scheduling, routing, and energy management. By considering traffic conditions, charging station availability, and user demand forecasts, the proposed solution aims to minimize waiting times, maximize vehicle utilization, and reduce operational costs. Furthermore, the research will explore the integration of renewable energy sources into the charging infrastructure, further enhancing the sustainability of e-SAV fleets.

The outcomes of this research will provide insights and practical strategies for city planners, policymakers, and transportation companies to implement efficient and sustainable e-SAV systems. Ultimately, this project seeks to contribute to the broader goals of reducing urban congestion, lowering greenhouse gas emissions, and promoting sustainable urban transportation solutions.

Transport Analytics Research Lab

Minh Kieu

Project open until: December 2025

Fields of research: Engineering; Transportation and freight services; Transport engineering; Transport planning

Assessing and Improving Transport Resilience in New Zealand

This research project aims to assess and enhance transport resilience in New Zealand by identifying vulnerabilities and developing strategies to improve response and recovery from disruptions.

This research project focuses on assessing and improving transport resilience in New Zealand, with the aim of enhancing the ability of transport systems to withstand, adapt to, and recover from various disruptions, including natural disasters, accidents, and infrastructure failures. New Zealand's unique geographic and environmental conditions make its transport networks particularly vulnerable to events such as earthquakes, floods, and landslides. This project will analyze current transport resilience levels, identify critical vulnerabilities, and develop strategies to strengthen the robustness and reliability of the transport infrastructure.

The research will utilize a multidisciplinary approach, incorporating quantitative risk assessments, spatial analysis, and simulation modeling to evaluate the impact of potential disruptions on transport networks. By integrating real-time data and advanced predictive modeling, the study aims to provide actionable insights for improving emergency response, optimizing resource allocation, and enhancing recovery efforts.

Key outcomes of the project will include a set of recommendations for policymakers and stakeholders to enhance transport resilience, prioritize investments in critical infrastructure, and develop adaptive strategies for future-proofing New Zealand's transport systems. This research will contribute to broader goals of sustainable development and disaster preparedness, ultimately ensuring more reliable and resilient transportation for all New Zealanders.

Transport Analytics Research Lab

Minh Kieu

Project open until: December 2025

Fields of research: Engineering; Transportation and freight services; Transport engineering; Transport planning

Integration of Remote Sensing and AI for Real-Time Monitoring of Urban Mobility and Air Quality

Objective: Develop an AI-driven model using remote sensing data to predict the impact of urban mobility patterns on air quality in real-time.

As urban populations expand, cities encounter growing challenges in managing mobility and air quality. Traditional monitoring methods often lack the real-time capabilities necessary for effective decision-making and intervention. This project focuses on integrating remote sensing data with artificial intelligence (AI) to develop a comprehensive system for real-time monitoring and analysis of urban mobility and air quality.

The research will leverage satellite imagery, drones, and ground-based sensors to capture detailed data on traffic pat erns, vehicle emissions, pedestrian flows, and atmospheric conditions. AI algorithms will be designed to process and analyse this multifaceted data, enabling the real-time detection of pollution hotspots, traffic congestion, and mobility trends across various modes of transportation.

By relating mobility data—such as GPS movement data, traffic volumes, vehicle speeds, and public transit usage—with air quality indicators, the study will offer deep insights into the direct and indirect impacts of mobility on urban air pollution. This integration will enable the prediction of air quality trends based on dynamic mobility pat erns, providing valuable guidance for urban planners and policymakers.

The system could facilitate dynamic traffic management strategies, such as optimizing traffic flow, adjusting public transit routes, and rerouting vehicles to minimize emissions in heavily polluted areas. Ultimately, this research aims to contribute to the development of smarter, more sustainable cities by offering tools for proactive and informed decision-making in urban mobility and environmental management.

Katarzyna Sila-Nowicka
Thomas Dowling
Hyesop Shin

Fields of research: Engineering; Information and computing sciences; Geomatic engineering; Cartography and digital mapping; Geospatial information systems and geospatial modelling; Navigation and position fixing; Applied computing; Spatial data and applications

AI-Driven Energy-Based FAIR Platform for Credible Digital Twins in Healthcare

Credible virtual twins in healthcare integrate diverse data using FAIR principles. We aim to develop an AI-driven platform for automatic model and data discovery.

Achieving precision medicine through Digital Twins relies on effective integration and processing of extensive digital research objects, including experimental and clinical data, computational models, and literature. The FAIR (Findable, Accessible, Interoperable, and Reusable) principles facilitate machine discovery and utilization of these objects. Standards for computational models, such as CellML and SED-ML, provide standardized encoding of mathematical models and simulations, supporting FAIR practices in biological research. Given the complexity of physiological systems, an energy-based framework is desirable for modeling mechanics, electrical potentials, biochemical reactions, and metabolic energetics dynamics, allowing for integration across different domains using energy as a universal language. Furthermore, advanced AI technologies, such as large language models (LLMs), can efficiently interpret and extract vast information from literature. We aim to leverage community standards, energy-based formalisms, and AI techniques to explore a novel platform for the automatic integration of models, data and literature, thereby enabling credible Digital Twins development in healthcare. Research directions include, but are not limited to:

1. AI-driven semantic annotations for improved knowledge retrieval and integration.
2. Development of search engines to improve the discovery of scientific data and models for parameterization and personalization.
3. Creation of a novel platform for automated multi-scale model integration.

Building a search tool for compositely annotated entities using Transformer-based approach
Hierarchical semantic composition of biosimulation models using bond graphs
Model annotation and discovery with the Physiome Model Repository

David P. Nickerson
Weiwei Ai

Project open until: December 2030

Fields of research: Engineering; Information and Computing Sciences; Biomedical engineering; Computational physiology; Data management and data science; Machine learning; Software engineering; Data models, storage and indexing; Data mining and knowledge discovery; Information extraction and fusion; Information retrieval and web search; Query processing and optimisation; Recommender systems

Developing a Multiscale Knowledge Resource for Personalized Predictive Research in Chronic Kidney Diseases (CKD)

The aim of this project is to develop a knowledge resource that connects disparate information across the physical scales from genotype to whole organ systems for personalized predictive health research.

This project is focused on developing a multiscale knowledge resource that builds on the functional annotations of genomic, metabolic data, and semantic annotations of computational physiology models that will support the efforts of the virtual human twin. Through the use of knowledge graphs, natural language processing, computational physiology, organ scaffolds, machine learning and ontological databases we will construct connected networks that will be used to further research in chronic kidney disease.

We are looking for talented engineers and scientists to join our motivated team working on this exciting goal. Current projects range from linking medical ontological databases to computational models at the cell and tissue level, through to the development of thermodynamically feasible multiscale predictive models for physiology. Specifically this project will involve:

- Data integration and functional annotation of genomic and metabolic data from large scale genomic studies and metabolic profiles relevant to CKD as well as computational physiology models related to kidney function and CKD progression.
- Knowledge Graph construction that connects genomic, metabolic, and physiological data across multiple scales.
- Using NLP techniques to extract relevant information from scientific literature, clinical records, and other unstructured data sources.
- Applying machine learning algorithms to the knowledge graph to predict disease progression, treatment outcomes, and patient-specific risks in CKD.

David Nickerson
Weiwei Ai
Chang-Joon Lee
Anand Rampadarath (Plant & Food Research)

Project open until: December 2026

Fields of research: Engineering; Information and Computing Sciences; Biomedical Engineering; Computational Physiology

Particle-Based Computational Modelling of Solid Food Breakdown during Gastric Digestion

In this project you will develop an advanced computational model using particle-based techniques to simulate and predict the breakdown of solid foods during gastric digestion.

This project aims to create a novel computational framework for modelling solid food breakdown during gastric digestion using advanced particle-based methods. The research will primarily utilize smoothed-particle hydrodynamics (SPH) coupled with other particle-based methods to simulate the complex physical interactions between food particles and gastric fluids.

The project will involve:

1. Developing a SPH-based model of the gastric environment, including realistic stomach geometry and motility pat erns.
2. Implementing a multi-scale particle representation of various food types, considering their initial structure, composition, and mechanical properties.
3. Incorporating models for chemical reactions, including enzymatic activity and pH changes, to affect particle properties over time.
4. Simulating the mechanical forces exerted by stomach contractions on food particles.
5. Modelling the gradual breakdown of solid food particles, including changes in size, shape, and density throughout the digestion process.
6. Implementing gastric emptying mechanisms to model the movement of broken-down particles through the pylorus.
7. Validating the model using experimental data from in vitro digestion studies and available in vivo data.

This research will provide detailed insights into the dynamics of food digestion, potentially aiding in the development of optimized food structures for improved digestion and nutrient absorption.

Nadun Palmada
Leo Cheng

Fields of research: Engineering; Mathematical Sciences; Biomedical engineering not elsewhere classified; Biomedical engineering not elsewhere classified; Numerical analysis; Numerical analysis

Hetero-Dimensional Cardiovascular Digital Twins for Precision Medicine

Development of computational tools to streamline the generation and resolution of efficient cardiovascular system models with coupled hetero-dimensional components for clinical applications.

Constructing comprehensive, subject-specific cardiovascular system (CVS) models for clinically feasible simulations still represents a significant challenge due to model complexity, parameters identification and calibration, and the need to access large computational resources.

This project is part of an international collaboration between New Zealand and Europe to develop the first personalized digital representation of a human that can be used for diagnosis, treatment, and prognosis in medical practice. We envisage the translation of this methodology to shift the medical paradigm to treat diseases based on patient-specific physiology instead of population statistical analysis.

This project aims to develop integrated computational and software tools to streamline the generation of efficient, purpose-specific CVS models of variable complexity, leveraging different 0D, 1D, and 3D coupled components (heart and vessels). These tools will be based on energy-preserving coupling techniques between hetero-dimensional cardiovascular components, and efficient algorithms for parameters identification based on available clinical data. This methodology will allow the simplification or extension of a CVS model by dynamically exchanging 0D/1D/3D components in different CVS portions, depending on: the application of interest, an identifiability analysis, required levels of accuracy of results and computational efficiency. This framework will enable us to perform clinically feasible simulations in subject-specific CVS models.

Horizon VITAL Project
Animus Laboratory

Beatrice Ghitti
Gonzalo Maso Talou
Finbar Argus
Peter Hunter

Project open until: June 2025

Fields of research: Engineering; Mathematical Sciences; Biomedical engineering; Computational physiology; Biomechanical engineering; Numerical and computational mathematics; Numerical and computational mathematics not elsewhere classified

Babies Born Too Small, can we Predict and Improve Their Growth?

In pregnancy the physiology of both mother and baby changes remarkably. We are developing a virtual pregnancy (a pregnancy that lives on a computer) that can predict problems that may arise in pregnancy. We have a range of projects available which focus on using computational skills to better understand pregnancy and to predict problems.

Healthy development depends on how the physiology of both mum and baby interact, and how mum delivers oxygen rich blood to baby. Despite the critical relationship between mum and baby's circulations, which defines our health for the 9-months of pregnancy, we still have major gaps in our knowledge of how one circulation impacts the other. For example, does delivery of nutrient rich blood from mum impact on how the baby's lifeline (the placenta) develops, and how does placental development impact on the development of the baby's own circulation? This is critical to understanding and managing the pregnancies in which babies are born too small, which has major impacts not only on the rate of stillbirth but also on lifelong cardiovascular health for these babies.

In our group we are combining state of the art imaging (micro-CT, magnetic resonance imaging) with laboratory experiments (e.g. cell culture) and computational modelling of the interactions between mum and baby in pregnancy to provide exciting new insights into how we develop before we are born. We have opportunities across all these areas of research to work with a dynamic and multi-disciplinary team in solving some of the mysteries of what makes a healthy pregnancy.

Desired skills: We have a range of projects available. These include computational/mathematical modelling, imaging and image analysis, and if interested a combination of experimental and computational work.

Alys Clark

Project open until: January 2026

Fields of research: Engineering; Mathematical sciences; Computational physiology; Biomedical imaging; Biological mathematics

Automated Concession Pricing for Toll Road PPP Projects

The aim of the research is to achieve an automated concession price determination and negotiation for toll road infrastructures financed as public-private partnerships.

One of the critical concession parameters for a PPP project is the concession price. It determines the project's commercial viability and profitability and is frequently the focus of discussions during the negotiation period. In addition, a toll-adjustment mechanism during the operational phase can contribute to the effective management of the traffic demand risk. Existing pricing models for determining initial concession prices and dynamic adjustments require further improvement. This research focuses on enhancing pricing models for toll road PPP projects by improving traffic volume predictions, incorporating social benefits into pricing decisions, and designing dynamic adjustment strategies under information asymmetry. The aim is to achieve an automated concession price determination and adjustment for more effective toll management and risk-sharing.

Hongyu Jin

Project open until: 2025

Fields of research: Engineering; Mathematical sciences; Civil Engineering; Construction engineering; Applied mathematics; Operations research

Examining First and Last Mile Journeys of Public Transport from an Equity, Income and Gender Lens

First and last mile trips can be overlooked in developing countries. The present study contributes to the very limited work on understanding barriers of these connecting trips from an equity perspective.

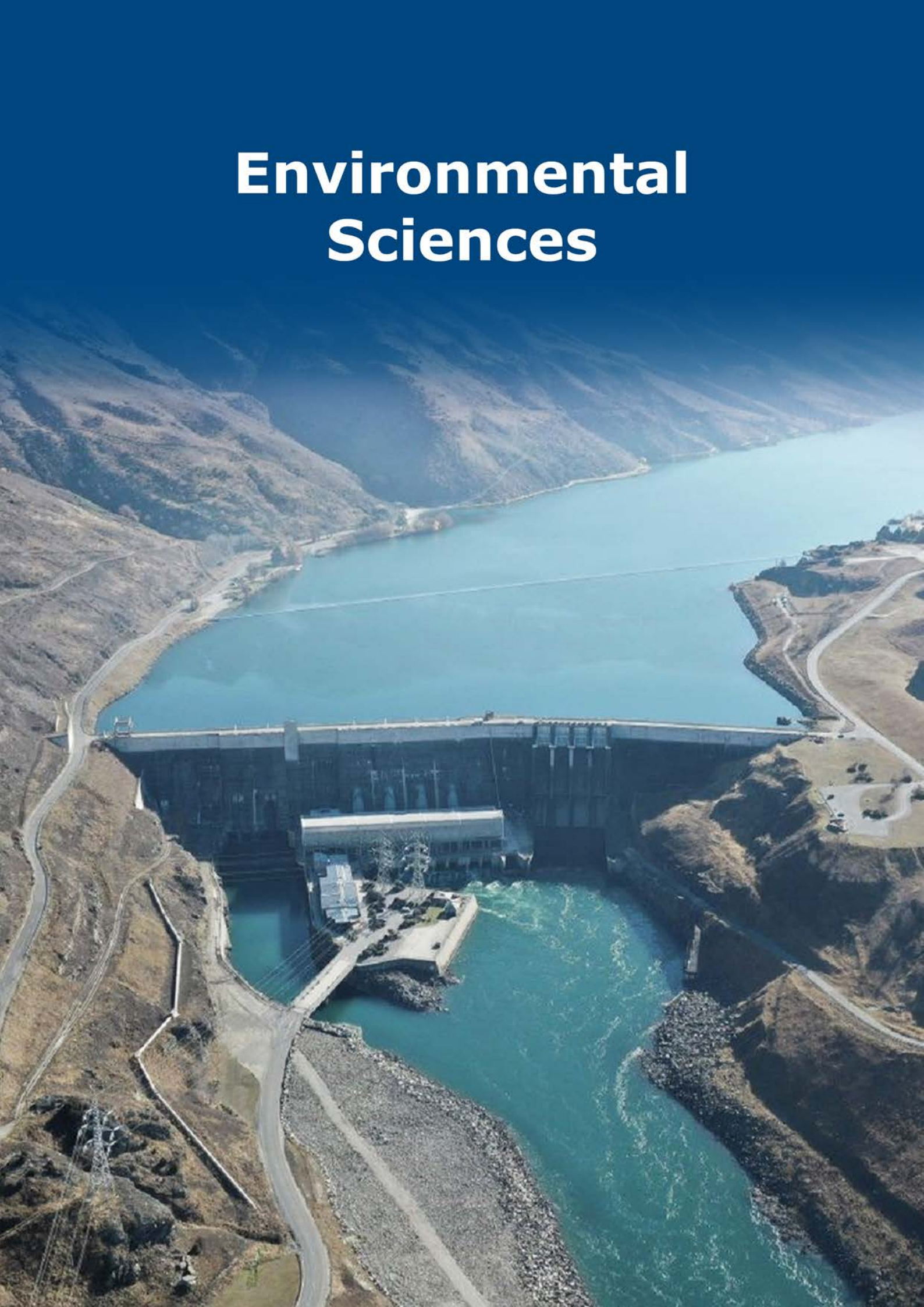
The ease of making first-and-last-mile trips to public transport stations is critical to ensure access by different population groups. Most women prefer to walk to public transit stations to reduce journey cost, if the distance is short and in a pedestrian-friendly environment. Gendered travel pat erns for first-mile trip can greatly vary based on a person's perception on safety, built environment, travel time and distance to stations. Built environment around public transit stations have a strong positive influence on women's walking trips in comparison to men. Alongside this, for women, fear of victimisation has a strong influence on their walking route, return journey time and mode choice. There is a significant disparity in the number of studies undertaken in developed and developing countries.

The focus of the present study is to investigate the barriers inherent in first and last mile trips of public transport journeys. In a developing country, such connecting trips can have inequity given the user's socio-economic characteristics. Findings from the study will contribute to developing equitable public transport systems.

Subeh Chowdhury

Fields of research: Engineering; Psychology; Built environment and design; Human society

Environmental Sciences



Employing Artificial Intelligence and Remote Sensing Technologies for Early Detection and Response

This study aims to address the growing challenge of wildfires by employing deep neural networks for risk assessment, early detection, and fire line spread prediction. The project offers a valuable opportunity for students to engage with cutting-edge technologies in machine learning and contribute meaningfully to wildfire management and mitigation efforts.

This research is focused on tackling the growing danger of wildfires by creating AI solutions for predicting, detecting, and responding to wildfires. While wildfires are a part of the earth's cycles, they now present significant risks to ecosystems, property, air quality, and human well-being. By utilizing data from satellite-based sensing systems like MODIS, VIIRS, and Sentinel 3 this project aims to generate comprehensive datasets for identifying active fires and analyzing fire radiative power (FRP).

Through the application of deep learning methods, this endeavor aims to improve assessments of wildfire susceptibility, detect wildfire outbreaks quickly, and forecast fire spread. Various models such as Convolutional Neural Networks (CNNs), Recurrent Neural Networks (RNNs), and Transformers will be utilized along with techniques like transfer learning to enhance model accuracy and dependability. Additionally, new AI algorithms will be developed to map fire perimeters and anticipate the rate at which wildfires spread. These advancements will provide insights for swift emergency response actions and mitigation strategies.

The anticipated results include creating AI models that can precisely evaluate wildfire risks, minimize detection inaccuracies, and offer dependable predictions about wildfire behavior. This effort is expected to contribute towards enhancing wildfire management practices and providing essential resources for addressing fire-related crises.

Waleed Abdulla
Delwyn Moller

Funding: Scholarship from project

Fields of research: Environmental sciences; Climate change impacts and adaptation; Climate change impacts and adaptation not elsewhere classified

Understanding human Impacts on Coastal Seafloor Ecology and Processes

We investigate the interconnected ways human activities both on land and in the sea alters biodiversity and ecological functioning in coastal soft sediment habitats and how these impacts affect society.

Globally, coastal seafloor habitats are severely impacted by human activities occurring both on land and in the sea, putting at risk the many benefits (e.g. food production, carbon sequestration, cultural values) provided to society. Our research focuses primarily on building fundamental knowledge on how this vital ecosystem works, specifically on how ecological connections and networks respond to human generated stress. We are also actively engaged with communicating research to inform bet er policy and management of the coastal zone. Current areas of active research include multiple stressor impacts, climate change, biodiversity-ecosystem functioning relationships, quantifying the work nature does for people, remotely sensed assessments of ecological functioning, disturbance-recovery dynamics, conservation, and blue carbon dynamics. Although we are primarily bio-physical scientists/ecologists we collaborate with researchers in other disciplines including data science, remote sensing, engineering, modellers, social sciences, creative arts, policy and law. Many of our projects feature a high-level of co-development with Māori (Indigenous people of Aotearoa New Zealand) knowledge holders. We welcome students who are interested in pursuing research that spans research disciplines and world views. We have extensive links nationally and internationally and have a vibrant laboratory of research students from across the world.

Simon Thrush
Conrad Pilditch
Rebecca Gladstone-Gallagher

Fields of research: Environmental sciences; Climate change impacts and adaptation; Ecological applications; Environmental management; Carbon sequestration science; Ecological impacts of climate change and ecological adaptation; Ecosystem function; Ecosystem services; Landscape ecology; Conservation and biodiversity; Environmental assessment and monitoring

Marine Restoration

Coastal ecosystems around the world have been impacted by multiple stressors. This project works to understand how coastal ecosystem functioning has been affected, and how restoration can help improve degraded areas.

The restoration of benthic habitats and the re-invigoration of shellfish habitats is a key concern raised by indigenous groups, communities, and stakeholders, and is highlighted in recent regional strategies with end-users only lacking knowledge of the best approaches to apply. The Institute of Marine Science at the University of Auckland in New Zealand is working on the restoration of coastal shellfish species as part of a larger collaborative programme working to restore coastal ecosystems across New Zealand. Designing effective methods for supporting the long-term viability of restoration and enhancing biodiversity and ecosystem service benefits will also create pathways to enhance community capacity to implement restoration. This research involves working with indigenous Māori groups, community groups, and agencies to achieve restoration goals.

Researching Shellfish Restoration In Aotearoa New Zealand

Jenny Hillman
Andrew Jeffs
Simon Thrush

Project open until: December 2026

Fields of research: Environmental sciences; Environmental management; Environmental rehabilitation and restoration

Ecosystem Resilience under Environmental Change

Research in the broad area of ecosystem resilience to environmental change; methods used could include a blend of simulation modelling, species distribution modelling, and fieldwork.

This is a broad research area with strong fundamental and applied components; I would be happy to discuss specific details (questions, methods) with interested potential research students.

George Perry lab

George Perry
Kevin Simon

Fields of research: Environmental sciences; Biological sciences; Climate change impacts and adaptation; Fire ecology Landscape ecology; Ecology; Community ecology (excl. invasive species ecology); Palaeoecology; Freshwater ecology

Our Changing Forests

Our research explores the broad range of threats facing forest ecosystems from deforestation and pathogen outbreaks to environmental change.

Humans depend on the ecological services forests provide, yet globally, forest ecosystems continue to face large-scale threats. New Zealand's forests are no different. Since the mid-13th century (the time of Polynesian set lement in New Zealand) our forests have declined from nearly 90% of land cover to less than 25% today. The unique features of our indigenous forests, alongside the challenges of deforestation, pathogens and climate change provide a rich range of research opportunities. Our research in this area focuses on the dynamics of forest environments' past, present and future. It broadly encompasses the long-term dynamics of forest environments and interactions between forests and environmental change. We utilize a variety of approaches and tools to address these questions, including field-based empirical science, laboratory studies, dendrochronology, stable isotope (carbon, nitrogen, oxygen, and hydrogen), modelling and remote sensing.

Luitgard Schwendenmann
Gretel Boswijk

Project open until: December 2025

Fields of research: Environmental sciences; Biological sciences; Ecological applications; Ecosystem function; Ecology; Terrestrial ecology

Fate and Effect of Nanopesticides

Desk, lab and/or field investigations into the mobility, degradation and toxicity of nanopesticides

The application of nanotechnology in agriculture is currently receiving substantial at ention worldwide. The most common idea is to exploit the novel properties that materials develop at the nano scale to design agrochemicals with superior properties to the products currently used. For instance, the greater surface area of smaller particles provides them with faster dissolution kinetics, greater reactivity, and in the case of pesticides and fertilisers, a potential greater efficacy. Nanoencapsulation can also be used to deliver active substances at the right time and at the right place in line with the principles of high precision agriculture. Through a range of strategies, nanotechnology can thus reduce the amount of chemicals that needs to be sprayed to achieve crop protection and/or nutrition. There is a consensus that potential applications and benefits are immense.

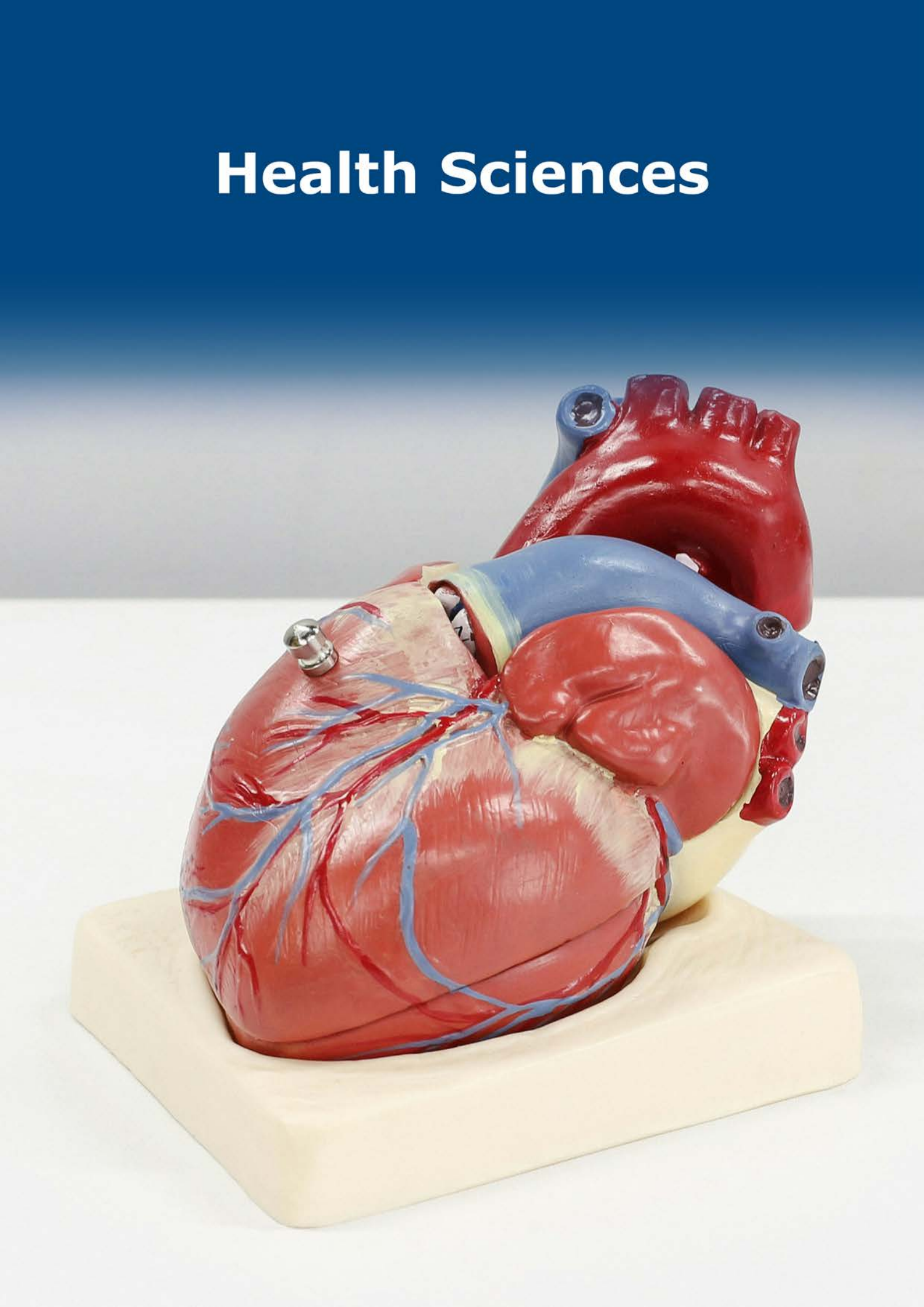
To harness its full innovation potential and impact, the development of nano-enabled agrochemicals needs to be carefully guided so that products that are beneficial to end-users are effectively developed and applied in a sustainable way. This project will look at a range of nano-enabled agrochemicals and investigate their mobility and degradation in soil in comparison to non-nano equivalents. Ecotoxicity towards soil and aquatic organisms will also be studied and critically evaluated in the context of the sustainable applications of nanotechnology in agriculture.

Melanie Kah

Project open until: December 2026

Fields of research: Environmental sciences; Environmental biotechnology; Environmental nanotechnology and nanometrology; Environmental biogeochemistry

Health Sciences



Exercise Sciences: Health, Rehabilitation and Human Performance

The Department of Exercise Sciences (QS subject ranking = #28) has projects available and specialist laboratories to support research in four main areas: 'exercise and physical activity', 'health and reablement', 'human performance', and 'neurodiscovery'.

Exercise and physical activity: We investigate how specially designed exercise programmes can impact health outcomes for people with chronic disease, and across the lifespan. Our on-site Health and Rehabilitation Clinic is a central resource for supporting research activity in this research area.

Health and reablement: We investigate new approaches to enhancing health and recovery in people living with acute and chronic conditions, from childhood to the older adult. We study effects of novel interventions on function and recovery, and the impact of disease and injury on physical activity, sedentary behaviour, and quality of life.

Human performance: We investigate physical function in healthy people and to enhance performance for athletes and non-athletes alike using state of art facilities. We aim to increase understanding of exercise metabolism and nutrition, improve movement efficiency through biomechanical analysis, and understand how psychophysiological states such as anxiety, fatigue and sleep, influence human performance.

Neurodiscovery: Our researchers study the human brain. We investigate underlying principles in the preparation, planning and execution of action, explore how the nervous system controls the actions of muscles to produce human movement, develop novel rehabilitation strategies for people with impaired movement, investigate brain fatigue, and examine interventions that improve brain health and performance.

We encourage students to orient themselves on a topic and contact prospective supervisors via email, prior to applying: further information.

Requests for more information may also be directed to the Department of Exercise Sciences Doctoral Advisor: pgadvice-exercise@auckland.ac.nz

Funding: Scholarship from project

Fields of research: Health sciences; Allied health and rehabilitation science; Epidemiology; Sport science and exercise; Physiotherapy; Rehabilitation; Allied health and rehabilitation science not elsewhere classified; Behavioural epidemiology; Biomechanics; Exercise physiology; Motor control; Sports science and exercise not elsewhere classified

Breastfeeding Duration in NZ: Associations with Diet Quality and Obesity in Early and Mid-Childhood

Data from the largest birth cohort in NZ (Growing up in New Zealand) will be used to investigate the social and maternal determinants of any and exclusive breastfeeding duration, their associations with diet quality at 2 and 4.5 years, and with child obesity at 4.5 and 8 years.

The protection, promotion, and support of breastfeeding is central to countries' commitments to the 2030 Agenda for Sustainable Development Goals. Among the numerous benefits of breastfeeding to society, studies have been reporting its association with bet er diet quality in early life and the reduced risk of child obesity. However, these relationships are complex and could be influenced by confounding factors. NZ has high rates of child obesity and substantial inequities for this health indicator. Despite this scenario, the country lacks national evidence on the determinants of breastfeeding and its associations with diet quality and obesity in childhood. This information is crucial for policy planning and for the country to advance towards meeting the global breastfeeding targets, improving diet quality in early life, and preventing child obesity. Data from a multiethnic birth cohort with more than 6000 children will be used, and a life course approach will be adopted. This project will use the information on breastfeeding indicators and on children's whole diet quality at 2 and 4.5 years. Information on body-mass-index and waist-to-height ratio will be sourced from the 4.5 and 8-year time points. Variables on maternal socio-demographics and health behaviours will be obtained from the antenatal interview. Associations will be examined via hierarchical modelling, survival analyses, and other multivariate techniques. At least 2 original papers and one systematic review are the expected research outputs originating from the PhD thesis.

1. Growing up in New Zealand Cohort Study
2. Castro TG, et al (2021). British Journal of Nutrition. doi:10.1017/S0007114521001720
3. Castro TG, eta al (2022). Maternal & Child Nutrition.

Teresa Gontijo de Castro
Clare Wall (Mentor Co-Supervisor)
Beatrix Jones (Co-Supervisor)
Leonardo Pozza dos Santos (Advisor)

Fields of research: Health sciences; Epidemiology; Nutritional epidemiology

Creating Workplace Cultures that Support the Thriving and Retention of Nurses

AIM: To provide a systematic quality improvement approach to the creation of workplaces that support nurses to thrive at work. An action research approach is used to engage nurse leaders and nurses to develop supportive organizational management approaches.

Based on positive organizational scholarship, the IHI Joy in Work model and Thriving at Work scholarship, this research starts by asking staff at all levels: “What mat ers to you?”. Then co-design approaches are used to enable all parties to share their voices and co-create constructive approaches that will improve organizational support. The end goal is the development, with the input of all parties, of a Report Card or Balanced Scorecard of what steps or actions have been agreed on which is then reviewed annually and provides a systematic quality improvement approach.

A five-year research programme concentrating on early career nurses began in 2024 and will operate over 5 countries. There are also students at PhD and Masters levels researching mental health nurses, charge nurses and the role of career growth pathways in supporting nurses to thrive.

Stephen Jacobs
Cynthia Wensley
Willoughby Moloney

Project open until: February 2030

Fields of research: Health sciences; Health services and systems; Nursing; Health management; Health systems; Implementation science and evaluation; Nursing workforce

Exploring Markers of Ultra-Processing and Agreement Between Nutrient Profiling Models and the Nova System

Markers of ultra-processed foods (additives and processing techniques) will be identified and agreement between Nova and a nutrient profile model determined in New Zealand datasets of food products and purchases.

The Nova classification system, which categorises food products by level of processing, has become popular over the last decade. Evidence is emerging about the health effects of specific additives and processing techniques and this project will provide information on the prevalence of specific additives and processing techniques used in ultra-processed food products in New Zealand. The doctoral candidate will use the ingredient lists from a packaged food database to search for specific additives and develop a process for identifying specific processing techniques (e.g. extrusion). There has been debate around whether dietary guidelines in New Zealand should include recommendations to 'avoid ultra-processed foods' and whether this concept should be used to define 'unhealthy' foods and be applied to nutrition policies. This project will explore the agreement between ultra-processed food categorisation and the Nutrient Profile Scoring Criterion used in New Zealand to define 'unhealthy' foods, in a national dataset of household purchases. Sales data will be explored for foods identified as 'unhealthy' or 'ultra-processed', and the nutrient composition and alignment with New Zealand dietary guidelines will be determined for foods categorised as 'ultra-processed' but not 'unhealthy' and vice versa.

Sally Mackay
Kathryn Bradbury (co-supervisor)
Teresa Gontijo de Castro
Helen Eyles (advisor)

Fields of research: Health sciences; Public health; Public health not elsewhere classified

High Blood Pressure and Sympathetic Autonomic Transmission in the Carotid Body

To investigate how adrenergic neurotransmitters released from the sympathetic nervous system modulate the sensitivity of the carotid body and whether their modulation provides a novel way to lower blood pressure in hypertension.

Previous research linked aberrant activity generated in the carotid body to the pathological exaggerated sympathetic nervous system activity, which contributes to the development and maintenance of hypertension. Carotid bodies of spontaneously hypertensive (SH) rats exhibit pathological hyper-excitability that causes high blood pressure; however, the reasons for this are not fully understood. This project aims to determine the reasons as this may inform us of novel drugs to treat hypertension in humans.

Recently, our group demonstrated that the sympathetic innervation of the carotid body sensitises its activity in a feed-forward mechanism. The lat er appears to be, at least partly, mediated by α1-adrenoreceptors located either on the vasculature and/or glomus cells. However, the exact cell type involved remains elusive. Furthermore, we cannot rule out the contribution of other adrenergic receptors and neurotransmit ers, such as β-adrenergic receptors. The aim of this project is to further advance our knowledge of how the sympathetic input to the carotid body causes its hyper-excitability in hypertension. In this project, the doctoral candidate will be exposed to and acquire a multitude of skills, including in situ electrophysiology, live cell calcium imaging, and in vivo blood pressure radio-telemetry recordings. Additionally, our group has the expertise to perform a wide range of molecular assays including immunohistochemistry, RT-qPCR, RNA-seq and Western-Blot.

Translational Cardiorespiratory Research Lab

See relevant papers from the group here and here

Project team

Julian FR Paton
Igor Felippe
DXin Shen

Funding: Scholarship from project

Project open until: December 2025

Fields of research: Health sciences; Biological sciences, Allied health and rehabilitation science; Biochemistry and cell biology; Analytical biochemistry

Health Economic Evaluations of a Digital Personalised Prediction Tool for Asthma Attacks

Asthma affects nearly 300 million individuals worldwide. Poor asthma control leads to increased asthma attacks and hospitalisations, which contributes to increasing healthcare costs and disease burden. The availability of digital technology that can better monitor symptoms and potentially detect early attacks could have important health and economic benefits. This project aims to evaluate the health and economic benefits of a digital personalised asthma attack prediction tool.

Asthma affects approximately 262 million people and resulted in 461,000 deaths in 2019, contributing to increased healthcare expenditure and societal costs. In New Zealand, asthma is the second largest contributor to the total disease burden among all respiratory illnesses. Poor asthma control and hospitalisations are major contributors to disease burden and costs. Currently, asthma control and clinical decision-making rely on patient-reported symptoms and control. However, this self-reported symptoms can be subject to recall bias and variability. Digital technologies can be used to provide more objective markers of disease and support early detection of asthma at acks. A clinical trial (DIGIPREDICT - see online link below) is currently ongoing to use digital technologies to develop a personalised asthma at ack prediction tool. The aim of this project is to evaluate the health economic benefits of the intervention within the clinical trial. You will be working with a large multidisciplinary research team nationally and internationally and will conduct comprehensive economic evaluations of the study outcomes.

BMJ Open Respiratory Research

Amy Chan
Braden Te Ao
Jeff Harrison

Project open until: March 2027

Fields of research: Health sciences; Economics; Epidemiology; Epidemiological modelling; Applied economics; Health economics

Creating Care Solutions for Dementia Across Major Ethnic Groups in Aotearoa NZ

The IDEA (Impact of Dementia mate wareware and solutions for Equity in Aotearoa) group are looking for a PhD candidate to undertake a qualitative study about dementia care.

Dementia is a global health priority. The IDEA study will establish dementia prevalence and will include a significant qualitative component, interviewing people living with dementia and their families. We want to find out what leads to flourishing in care (strengths and successes in balance of care), and what solutions are required for each ethnic group to optimally deliver care to those with dementia. Expert knowledge needs to be gained from families, particularly regarding culturally appropriate care in order to co-create solutions for optimal balance of care. The doctoral candidate will assist the IDEA group with its goals of delivering solutions for care in dementia for each major ethic group.

Proposed tasks might include a literature review to summarise the existing knowledge about dementia care with a focus on what is known about dementia care within ethnic minority cultures relevant to NZ. This will be followed by qualitative analysis work using the data sets being collected by the IDEA study in Pakeha, Chinese and Indian communities and using a collaborative thematic analysis method. Qualitative supervision will be provided by experienced researchers. Opportunities to collaborate with Māori and Pacific groups will also be available so that all major ethnic groups are being included. Co-creation training will be provided in order to help relevant stakeholders create an understanding of what services may be best for each ethnic group's needs. Expected outputs include publications of qualitative analyses and co-creation work undertaken.

Ngaire Kerse
Emme Chacko

Funding: Scholarship from project

Project open until: March 2026

Fields of research: Health sciences; Psychology; Dementia care; Multiethnic dementia care

Suicide Prevention: Population Approaches

We have a range of suicide prevention projects exploring the effectiveness of population approaches to suicide prevention.

Our bicultural team is leading research projects including universal (e.g., restricting access to certain methods associated with suicide), selective (e.g., interventions in high risk populations such as adolescents) and indicated (e.g., safety planning, psychological therapy) interventions.

Sarah Fortune
Tania Cargo
Sarah Hetrick

Fields of research: Health sciences; Psychology; Epidemiology; Clinical and health psychology

Human Society

Urban, Economic and Political Geography

We are looking to develop projects that study the ways that political and economic practices are entangled in their spatial contexts.

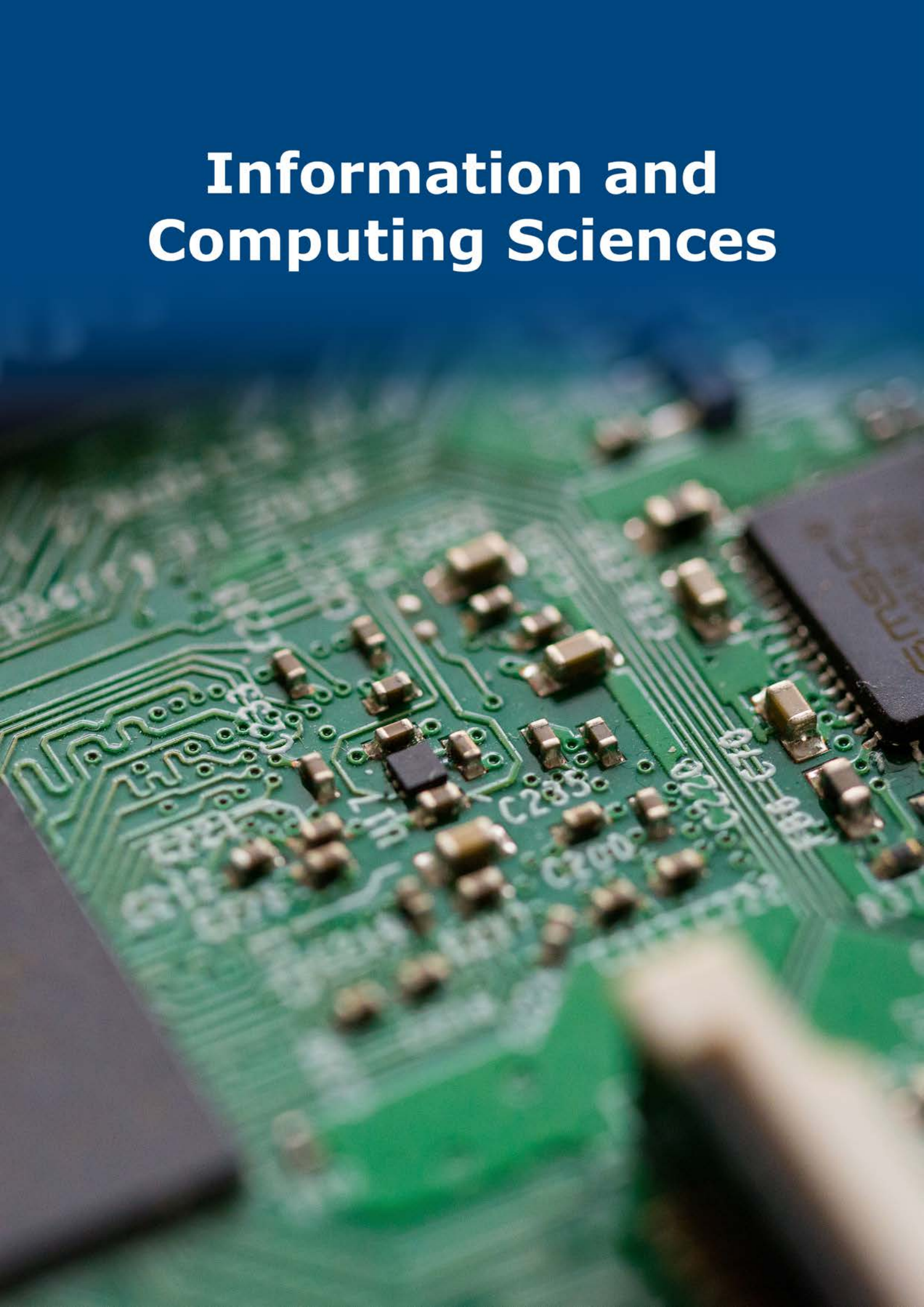
Through the Politics, Economies and Place research group, we are looking to develop projects that study the ways that political and economic practices are entangled in their spatial contexts, from cities and regions, to the nation and beyond. Politics (how we make collective decisions) and economy (how we steward resources to generate livelihoods and reproduce society) are central to the organisation of social and cultural life. We examine their spatiality as both source and outcome of social change at multiple scales. Our staff and postgraduate students research practices and actors in both micro (e.g. events, organisations) and macro (e.g. cities, regions, nations) spaces. We draw on insights from urban, economic and political geography, and are particularly interested in how post-structural ideas and practice-centred methodologies can enrich political economy critique of social change.

Politics, Economies & Place

Tom Baker
Laurence Murphy
Nick Lewis

Fields of research: Human society; Human geography; Policy and administration

Information and Computing Sciences



Advanced Radiological Analysis for Optimizing Brain Tumor Radiation Therapy

Unlocking the potential of cutting-edge radiological analysis in optimizing brain tumor radiation therapy. Join us to revolutionize cancer treatment.

This project integrates artificial intelligence and machine learning techniques with advanced radiological analysis to address two pivotal research questions in brain tumor radiation therapy. First, leveraging extensive datasets, we aim to employ deep learning algorithms to quantify the spread of radiation in normal brain tissue. By analyzing thousands of radiological images, we seek to map radiation dispersion in relation to tumor characteristics and location, refining radiation therapy protocols through AI-driven insights. Second, utilizing machine learning models, we aim to predict recurrent tumor locations based on initial radiation protocols and subsequent MRI scans, enabling clinicians to extend treatment boundaries effectively. Through these endeavors, we anticipate significant advancements in brain tumor radiation therapy, ultimately enhancing patient care and outcomes.

Alan Wang

Fields of research: Information and computing sciences; Artificial intelligence; Knowledge representation and reasoning

Intelligent Multisensory Data Analysis for Elderly Home Monitoring Using Spiking Neural Networks

Excited to explore how Spiking Neural Networks revolutionize elderly home monitoring? Join us in unravelling the power of intelligent multisensory data analysis.

This project introduces an innovative research endeavor aimed at employing spiking neural networks (SNNs) for intelligent multisensory data analysis within the realm of elderly home monitoring. With the global population aging, there is an escalating need for pioneering technologies that can facilitate elderly individuals' ability to age in place while ensuring their safety and well-being. This research endeavors to meet this demand by developing an advanced system capable of analyzing various sensory inputs from home environments, including audio, visual, and physiological signals, to detect and predict potential health issues or emergencies. Leveraging SNNs, a biologically inspired computational model renowned for its efficiency in processing temporal data and emulating human brain functionality, this project integrates cutting-edge machine learning techniques to enhance the accuracy and reliability of elderly home monitoring systems. The project entails the creation and implementation of novel algorithms for data fusion, anomaly detection, and predictive modeling, tailored specifically to address the unique needs and challenges of the elderly population. Through early detection of health issues, facilitating timely interventions, and providing personalized care and support, this research has the potential to significantly enhance the quality of life for elderly individuals.

Alan Wang

Fields of research: Information and computing sciences; Artificial intelligence; Knowledge representation and reasoning

Machine / Deep Learning in Neuroimaging Quantifications

This project aims to develop innovative machine/deep learning algorithms for big data analysis, robust pooling and harmonization of neuroimaging data with different acquisition protocols, and finding new representations from large amounts of neuroimaging data to classify diseases, predict disease progression, and assess recovery from neurological and psychiatric disorders in the future.

We will develop innovative machine / deep learning algorithms for big data analytics, robust pooling and harmonization of neuroimaing data with varying acquisition protocols, and finding new representations from large cohort of neuroimaging data in order to classify diseases and predict disease progression and evaluate future recovery in neurological and psychiatric diseases. The major focus will be on the MRI neuroimaging quantification in concussion, dementia, stroke, and Parkinson's disease. 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).

Alan Wang

Fields of research: Information and computing sciences; Artificial intelligence; Knowledge representation and reasoning

VeinGuard: Advanced Palm and Wrist Vein Recognition for Secure Biometric Authentication

This project focuses on developing a secure, accurate biometric authentication system using palm and wrist vein recognition through advanced machine learning algorithms and contactless image acquisition technology.

Palm and wrist vein recognition is a pat ern recognition challenge that offers enhanced security compared to traditional biometrics like fingerprints and facial recognition. This technology works by capturing the unique vein pat erns beneath the skin of the palm and wrist, making it difficult to forge. The recognition process involves several stages: image acquisition, preprocessing, feature extraction, matching, and decision-making. To ensure reliability and accuracy, it is crucial to efficiently extract the invariant features of the palm and wrist veins from the captured images. As the database of vein images grows, the need for more efficient categorization methods and faster matching algorithms becomes essential. Integrating additional biometric features, such as palm and wrist geometry, should improve recognition accuracy further. The technology's security is underscored by the fact that authentication data exists within the body, making it nearly impossible to replicate. The contactless nature of palm and wrist vein scanners enhances hygiene and user acceptance, particularly in public and medical settings. This project seeks candidates with a Master's degree with sound expertise in pat ern recognition, deep machine learning algorithms, and electronic design. The objective is to develop an accurate biometric system using advanced machine learning techniques.

Waleed Abdulla

Fields of research: Information and computing sciences; Cybersecurity and privacy; Digital forensics

SecureVoice: Advanced Text-Independent Speaker Verification Using Deep Learning for Enhanced Identity Protection

Develop a text-independent speaker verification system using deep learning to enhance secure identity verification, focusing on performance in noisy environments and adaptability for mobile devices.

The authentication of identities is critical in any application that needs security, and this has largely been a problem in the past with identifiers such as identity cards. Biometric identification, especially voice recognition, is a bet er approach. Speaker recognition can be divided into two categories: speaker identification, where the system identifies who is speaking, and speaker verification, where the system confirms if the speaker's claimed identity is legitimate. Another variant, text-dependent sub-category, is a type of speaker recognition that requires the speaker to speak specific words, while text-independent requires no such requirement. While text-independent recognition is more complicated, it is more flexible and universally usable.

This project aims to investigate and implement a text-independent speaker verification system based on deep learning for security purposes. We are looking for candidates with experience in signal processing, speech processing, and deep learning. A candidate who publishes papers in the relevant field is advantageous. Some of the project's objectives include algorithms that work well in noisy environments or with distant speech and making some of the algorithms suited for mobile devices. This research will help enhance identity verification systems based on voice recognition to be more secure, reliable, and easy to use.

Waleed Abdulla

Fields of research: Information and computing sciences; Cybersecurity and privacy; Digital forensics

Power-efficient High Performance Computing (HPC) in small satellites

High-performance computing has moved into embedded systems where large amounts of processing needs to be done with lit le power. This project will investigate power-efficient high-performance algorithms in small embedded systems as found in satellites.

Most satellites in earth's orbit gather data from sensors which is then transmit ed to their ground station. This can be simple sensor readings, but often involves considerable amounts of data, for example when images are taken.

To reduce the amount of data to transfer, (pre-)processing of the data can already happen in the satellite. This can be done to reduce the amount of data, e.g. by compressing the data, or to carry out the processing of the data for the intended application, e.g. detecting objects in images. In either case, this means that the satellite needs to posses considerable computing capabilities.

At the same time, all satellites need to function with a limited power supply. This is especially true for small form-factor satellites like CubeSats. Hence, the necessary computing power needs to be achieved with as lit le power as possible.

In this project we will investigate the design and implementation of power efficient algorithms for the application in small Satellite. These algorithms will then be designed and implemented in low power embedded systems with GPUs and the emerging NPUs which provide realistic restrictions as one could find in a CubeSat computing system.

Oliver Sinnen

Fields of research: Information and computing sciences; Distributed computing and systems software; High performance computing; Energy-efficient computing

Distributed Machine Learning with IoT-based Sensors

This project aims to explore distributed machine learning techniques that can be directly applied to IoT-based sensors and offering real-time intelligent services.

IoT-based sensors are commonly deployed over a wide geographical area with limited computational power and energy. Existing centralised machine learning techniques do not work with IoT applications, and unique machine learning techniques are necessary to achieve the full potential of IoT technologies in intelligent sensing, monitoring, and servicing. This research aims to study and design the next generation distributed machine learning technique for IoT-based sensors and applications.

Kevin I-Kai Wang

Project open until: December 2025

Fields of research: Information and computing sciences; Distributed computing and systems software; Machine learning; Distributed systems and algorithms; Networking and communications; Neural networks; Reinforcement learning

Integrating Artificial Intelligence with Augmented Reality for Neurorehabilitation: Advancing Solutions for Spatial Neglect

As a PhD student in this project, you will pioneer the integration of Artificial Intelligence (AI) and Augmented Reality (AR) to redefine neurorehabilitation for spatial neglect.

Post-stroke spatial neglect, impacting a substantial proportion of right hemisphere stroke survivors, poses a formidable challenge in neurorehabilitation, often leading to prolonged hospital stays and unsatisfactory outcomes with conventional therapeutic approaches. Our project endeavors to develop an innovative Augmented Reality (AR) intelligent training programme to address the multifaceted dimensions of spatial neglect rehabilitation. Rooted in the principles of explorative action training, this program will harness state-of-the-art technologies to deliver personalized interventions and immersive experiences tailored to individual patient needs. Utilizing Flut er for development, the AR application will seamlessly operate across both iOS and Android platforms, ensuring broad accessibility and usability. Additionally, integration of Vision AI will augment user interaction through intelligent object detection, facilitating real-time feedback and enhanced engagement. Leveraging Unity's AR Foundation, encompassing ARKit and ARCore, will introduce immersive augmented reality elements, fostering a dynamic and captivating rehabilitation milieu. This holistic and patient-centered approach holds promise for revolutionizing post-stroke spatial neglect rehabilitation, offering a pioneering solution to address current therapeutic limitations and enhance patient outcomes.

Alan Wang

Fields of research: Information and computing sciences; Engineering; Artificial intelligence; Knowledge representation and reasoning; Biomedical engineering,

Combining Text and Visual Language Models to Generate Safe and Efficient Software.

Writing performant software programmes is challenging. Software engineering has seen significant uptake of Large Language Models (LLMs) for tasks such as automated patching of functionally incorrect programmes, to requirements engineering. However, LLM assisted correction of software performance-defects remains elusive. This project aims to fill this gap.

We develop a new LLM called CodeGem that combines text- language model (CodeGemma) and visual-language model (PaliGemma) to understand performance defects and assist developers in fixing these bugs. In doing so, we aim to improve:

(1) software efficiency of large software infrastructure thereby reducing its carbon footprint, (2) improve functional safety of AI-generated software, and (3) improve future developer productivity.

Software developers frequently use inefficient code sequences that leads to a waste of resources, and performance degradation. These inefficient code sequences are called performance defects. The pervasiveness of performance defects is because developers find it difficult to analyse whether a programme is performant, since there are only bet er or worse solutions — not right or wrong. The question then arises: can a Large Language Model (LLM), such as Google Gemini, help developers understand and write efficient software? Most time of a software programme is spent executing loops. Hence, LLM based automated loop optimisation will be the target of this research project.

Loops have a static representation — the Abstract Syntax Tree (AST) — and a dynamic representation/behaviour — memory access pat erns, dependencies, etc. The performance characteristics depend upon the dynamic behaviour of loop nests. However, LLMs usually have only learnt semantic relationship between different static representations. Hence, the novel idea is to fine tune the LLM to learn the semantic relationship between the static and dynamic representation of nests. We will combine the text-based LLM Google's codegemma and the visual language model called Google's paligemma to learn loop optimisations. Both these models will learn the polyhedral loop nest representation. Then, they will reinforce each other to optimise loops.

The overall result of the approach will be tested on loop nests from stencil computations, such as solving the heat equation.

Avinash Malik

Fields of research: Information and computing sciences; Natural language processing; Modelling and simulation; High performance computing

Column Generation Algorithm for Task Scheduling in Parallel Systems

Task scheduling is a strongly NP-hard problem, where only very small instances can be solved optimally. This project will investigate Column Generation techniques to this problem to significantly push the envelope of what is possible today.

Today, virtually all computers are parallel systems with multiple processors. To efficiently use such a system it is crucial to carefully map and schedule the tasks of a programme onto the processors. This is a very hard optimisation problem and can be described as a Mixed Integer Linear Program (MILP). Despite extensive research, only small instances can be computed optimally by modern solvers today.

Delayed Column Generation is an algorithm that has been successfully deployed for large MILP in other domains. The advantage is that not all possibilities need to be enumerated. One starts with a smaller problem and only brings in new variables as needed. In practise this can be significantly faster than directly solving the original MILP. In this project you will be investigating the modelling and implementation of the task scheduling problem with a Column Generation algorithm.

Oliver Sinnen

Fields of research: Information and computing sciences; Mathematical sciences; Distributed computing and systems software; High performance computing; Numerical and computational mathematics; Optimisation

Sustainable High-Performance Computing through Minimisation of Data Transfer

High-performance computing, especially machine learning tasks, need a lot of energy. This project tries to minimise this by looking at general methodologies and scheduling approaches.

Computer technology has truly conquered our work and life. While we strongly benefit from it, computing consumes an ever increasing fraction of our energy production. Making computing more energy-efficient is therefore of paramount importance, not least due to emerging computing needs of the sensational advances of machine learning and artificial intelligence. Technological advances have made computers more energy-efficient over the years, usually paired with smart approaches to benefit from these advances. For example, the speed of processors can be dynamically adjusted to reduce the power consumption and a lot of research has focused on algorithms using this. However, due to technological developments the movement of data has become a significant source of energy consumption in the computation of a programme. Almost all modern computers have more than one processor and data moves between the processors and the memories. Avoiding or minimising this data movement can significantly reduce the energy consumption of computers. In this project the PhD student will investigate a novel scheduling model and algorithms that can allocate and order sub-tasks of a programme onto the processors in such a way that the energy cost will be reduced, while maintaining similar execution speeds, hence making computing more sustainable.

Oliver Sinnen
Andrea Raith

Fields of research: Information and computing sciences; Mathematical sciences, Distributed computing and systems software; High performance computing; Energy-efficient computing; Numerical and computational mathematics; Optimisation

Can Immersive VR-Based Data Visualisation Help make more Effective Business Decisions?

We hypothesize that immersing a team of decision-makers in a virtual-reality environment can increase their ability to devise patterns and find relations that not only enhance data analytics but also resolve ambiguities.

New tools for data visualisation include the utilisation of virtual reality (VR) devices and a suitable setting to represent and present the data. Businesses may benefit from bringing together the increasing availability of data and more affordable, more reliable virtual reality software applications and devices.

We hypothesize that immersing a team of decision-makers in a VR environment can increase their collective ability to devise pat erns and find relations that not only enhance results produced by analytical processes previously run on the data but also resolve ambiguities and roadblocks by appealing to the higher sense of awareness afforded by the technology. Tests done in our Aroaro lab are already suggesting a positive effect for a particular set of problems in a peculiar data type.

Our Aroaro lab (www.aroaro.auckland.ac.nz) is equipped with VR technology to carry out application development as well as immersive testing.

This research seeks to make progress in reaching the most suitable visualisation techniques in a VR environment for team decision-making using business data of different types, with emphasis on network data sets. It also seeks to make progress on determining most suitable business needs that would require a set of coworkers to come together as a team to support managerial decision-making.

Fernando Beltran

Project open until: December 2025

Fields of research: Information and computing sciences; Psychology, Graphics, augmented reality and games; Virtual and mixed reality; Cognitive and computational psychology; Decision making

Ethical AI Practices

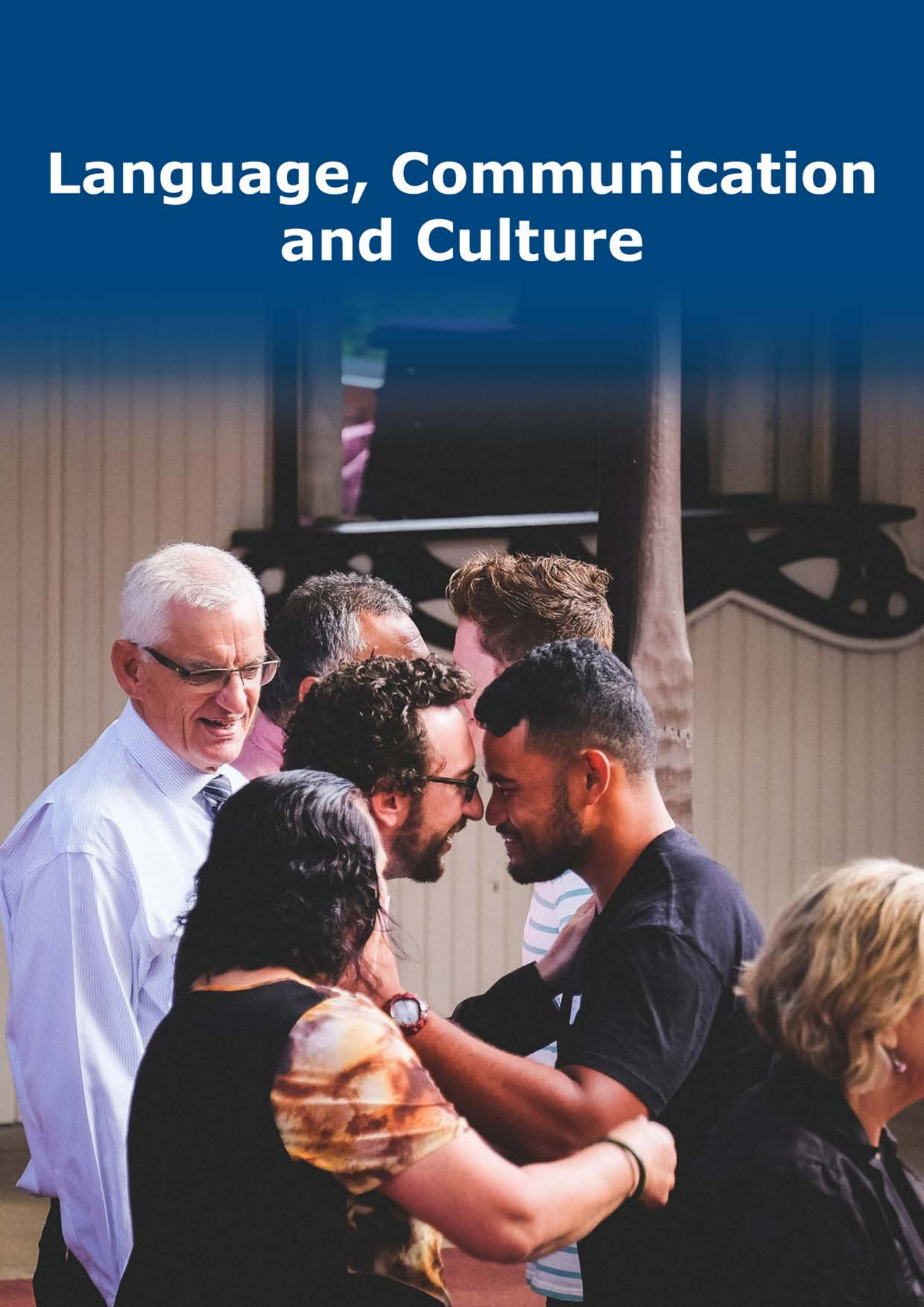
This project aims to investigate innovative approaches to address pressing issues when organisations design, deploy and use AI technologies in order to understand how to minimise injustice in organisational decision-making processes.

Given the opaque nature of AI-enabled solutions and their self-learning characteristics, it is inevitable that the design and training of AI solutions would inherit some biases from its training data, which may result in discriminatory outcomes, particularly in recruitment and justice. These biases exacerbate existing disparities and perpetuate social injustices. Moreover, AI also introduces ethical dilemmas, particularly when choosing whether to rely on algorithmic or human-driven decisions involving ethical considerations. Addressing bias, ensuring fairness, and resolving ethical dilemmas are critical concerns for contemporary organisations that require immediate at ention. This project aims to investigate innovative approaches to address these pressing issues when organisations design, deploy and use AI technologies in order to understand how to minimise injustice in organisational decision-making processes. We seek to contribute to the theory and practice that is concerned with responsible and fair use of AI technologies. The practical contribution of this project will include guidelines and/or frameworks to govern AI's ethical behaviour in the organisational context, ensuring it aligns with societal values and expectations. The findings and recommendations from this project will have implications for creating a more ethically sound AI-powered society.

Randy Wong

Fields of research: Information and computing sciences; Psychology; Information systems; Information systems organisation and management; Social and personality psychology; Social psychology

Language, Communication and Culture



Multilingual Societies (various specific topics related to this)

and

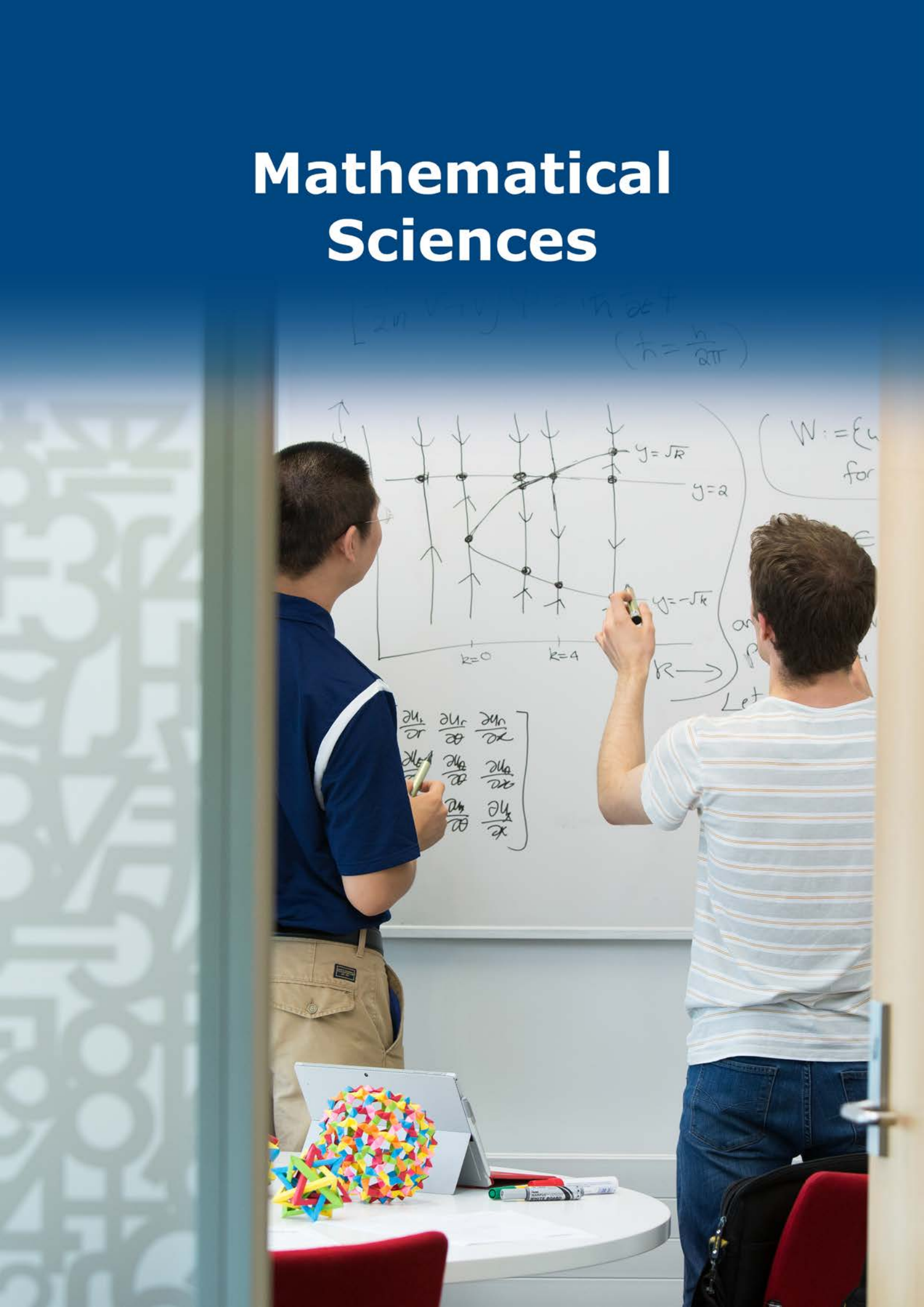
Digital Humanities & Political Discourse, Corpus-Informed Approaches (various specific topics related to this)

Louisa Buckingham

Project open until: December 2030

Fields of research: Language communication and culture; Communication and media studies; Other language, communication and culture; Religious studies; Communication technology and digital media studies; Other language, communication and culture not elsewhere classified; Religion, society and culture

Mathematical Sciences



Research Projects in Algebra and Combinatorics

Members of the algebra and combinatorics group conduct research in the fields of group theory, representation theory, graph theory, geometry, number theory, and applications.

There is a wide range of potential PhD projects in algebra and combinatorics. Possible research topics include studying vertex-transitive graphs with large automorphisms groups, investigating symmetry groups of geometric objects like trees or buildings, and computational problems in number theory and post-quantum public-key cryptography.

Algebra, Geometry and Combinatorics

Members of the algebra and combinatorics unit

Fields of research: Mathematical sciences; Pure mathematics; Algebra and number theory; Combinatorics and discrete mathematics (excl. physical combinatorics); Group theory and generalisations

Statistical Methods in Biomedical Studies

Developing statistical methods for biomedical research.

Projects:

1. Methodology for comparing diet across populations. Measurements of the diet are highly multivariate, and different contexts have different foods with similar nutritional roles (e.g. bread, rice, pasta). This project will develop statistical methods for characterizing dietary differences between populations, including analysis of diet surveys with complex survey designs.

2. Optimal design and analysis of subsampling studies. Given a large database of biomedical data it is often of interest to make new measurements on a subsample of the people, either for data validation from clinical notes/free text or for measuring new variables on stored samples. This project will be part of an ongoing international collaboration looking at the best ways to choose the subsamples and the best ways to analyse the resulting data.

3. Transfer of prediction models. New Zealand is a relatively small country and has a population that differs in significant ways from most Western countries (e.g. high immigration, substantial minorities of Māori and of Pacific Peoples). We want to study how best to transfer predictive models fit ed in other countries to work in New Zealand, or vice versa.

Thomas Lumley
Beatrix Jones
Yalu Wen

Project open until: December 2025

Fields of research: Mathematical sciences; Statistics; Biostatistics

Statistical Methodology

Properties of the One Standard Error Rule/Vector Generalized Linear Mixed Models/Topics in Information Geometry/Likelihood Theory and Asymptotics.

Properties of the One Standard Error Rule: Sequential analysis, multiple testing, statistical power, cross validation, model selection, hypothesis testing, asymptotic theory.

Vector Generalized Linear Mixed Models: Random effects models, numerical quadrature, longitudinal data, BLUP, penalized quasi-likelihood, iteratively reweighted least squares, Laplace approximation.

Topics in Information Geometry: Riemannian manifolds, expected (Fisher) information matrix, convex analysis, exponential families, divergence (e.g. Bregman and Kullback-Leibler), connections.

Likelihood Theory and Asymptotics: Hypothesis testing, higher order theory, statistical curvature, exponential families.

Thomas Yee

Project open until: December 2025

Fields of research: Mathematical sciences; Statistics; Large and complex data theory

Research in Probability

Various research projects in probability theory, including related to stochastic population models and saddle point approximations.

Jesse Goodman has projects investigating saddlepoint approximations for novel kinds of random variables, including point processes and marked point processes.

Simon Harris offers projects investigating the genealogies of samples of individuals selected from stochastic population models.

Probability and applications research

Simon Harris
Jesse Goodman

Project open until: 2027

Fields of research: Mathematical sciences; Statistics; Probability theory

Research in Ecological Statistics

At the University of Auckland, our researchers have expertise in developing new statistical methods for wildlife survey data that are used globally to answer questions of critical conservation concern.

Understanding animal populations from wildlife survey data is crucial for conservation, wildlife management, and fisheries stock assessments. The 21st century is seeing a massive expansion of survey capability due to the availability of new remote-sensing technologies such as drones, satellites, acoustic recorders, and trail cameras. However, data from these technologies raise numerous statistical challenges, and there are exciting opportunities for statistical PhD research in collaboration with biologists at the University of Auckland and worldwide.

We have researchers with particular expertise in developing statistical methods for spatial data in ecology, for fisheries stock assessments, and to estimate the population size and distribution of wildlife populations. We also focus on models with intractable likelihoods, with model fitting via either state-of-the-art approximation methods or alternative objective functions.

Ben Stevenson
Rachel Fewster
Jesse Goodman
Charlot e Jones-Todd
Russell Millar

Project open until: February 2026

Fields of research: Mathematical sciences; Statistics; Biostatistics; Statistics; Spatial statistics

Opportunities for Research in Applied Mathematics

The Applied Mathematics Unit is internationally renowned for its expertise in Applied Dynamical Systems. Related research involves chaotic fluid mixing, spatio-temporal pattern formation, advanced numerical methods and industrial mathematics.

A dynamical system is any system — biological, man-made, or physical — that changes in time. Many dynamical systems that model real-world phenomena cannot be solved explicitly and require the computation of approximate solutions that are sufficiently accurate to make predictions or recommendations. The Applied Mathematics Unit is interested in solving specific modelling problems arising in the industrial, physical, medical, or engineering sector, and in developing new mathematical theory, and designing advanced computational methods, which must be analysed to understand their properties, efficiency and accuracy. Research projects can, therefore, involve modelling and studying a specific application, or take the form of a purely theoretical or computational project, or a combination of these. Examples include the investigation of systems with multiple timescales when modelling the human lungs; the development of numerical methods for use in wave propagation phenomena, such as acoustic scat ering; or the study of complex spatial pat erns that arise during crystallisation of soft mat er.

Applied mathematics research

Members of the Applied Mathematics Unit

Project open until: 2035

Fields of research: Mathematical sciences; Physical sciences; Applied mathematics; Numerical and computational mathematics; Pure mathematics; Dynamical systems in application; Ordinary differential equations, difference equations and dynamical systems; Biological mathematics; Partial differential equations; Numerical Analysis; Optimisation; Atomic, molecular and optical physics; Classical physics; Condensed mat er physics; Lasers and quantum electronics; Acoustics and acoustical devices; waves; Thermodynamics and statistical physics; Soft condensed mat er

Opportunities for Research in Analysis, Geometry and Topology

The Analysis, Geometry and Topology Unit consists of a strong team of researchers, offering exciting projects in harmonic analysis, PDEs, tight frames, conformal and differential geometry, to name just a few.

Analysis is a corner stone of mathematics and deals with the properties of real and complex functions, differential equations, measure theory and related areas. These play a fundamental role in many disciplines including engineering, physics, economics, and biology. Our expertise extends into microlocal and semiclassical analysis, pluripotential theory, evolution equations, set-valued analysis and boundary problems for PDEs. A sample of research problems include:

- How do high energy solutions to PDE and pseudodifferential equations behave?
- How do random waves behave, what can we expect at a small scale?
- How to approximate plurisubharmonic functions and pseudoconvex sets?

Geometry and Topology are intertwined, thriving, fields of research, concerned with the study of the shape of spaces. They are used extensively in theoretical physics (general relativity, string theory), biology (protein folding) and cryptography (braid groups). Our members work on a wide range of research problems, such as:

- How to describe submanifolds and singularities by holographic means?
- How to construct invariants for singular geometric structures and for group actions on low-dimensional manifolds?
- How to construct and compute useful invariants of knots and links?

Research projects in these areas typically involve both a theoretical and a computational component.

Analysis, geometry and topology research

Members of the Analysis, Geometry and Topology Unit

Project open until: 2035

Fields of research: Mathematical sciences; Physical sciences; Mathematical physics; Numerical and computational mathematics; Pure mathematics; Algebraic structures in mathematical physics; Mathematical aspects of general relativity; Mathematical aspects of quantum and conformal field theory, quantum gravity and string theory; Numerical solution of differential and integral equations; Quantum Physics,

Physical Sciences

Astrophysics of Binary Stars, Supernovae and Gravitational Wave Sources

Topics in stellar astrophysics and the impact of binary stars on galaxies and the Universe.

This projects will include mainly theoretical work creating and using detailed numerical models of the evolution of stars. These will be compared to different observations such as observed supernovae, gravitational wave transients, high redshift galaxies and stars in our own galaxy. It will require programming skills and a good understanding of stellar evolution.

Binary Population and Spectral Synthesis

Jan Eldridge

Fields of research: Physical sciences; Astronomical sciences; Cosmology and extragalactic astronomy; Galactic astronomy; General relativity and gravitational waves; Stellar astronomy and planetary systems

Enhancing Mid-Infrared and Visible Fibre Laser Performance

Recent advancements in fluoride fibres have boosted mid-infrared and visible fibre laser performance. Ongoing projects with collaborators in Australia and Europe focus on developing high-power, broadband, and ultra-short pulse lasers.

Recent advancements in fluoride fibres have significantly enhanced the performance of mid-infrared and visible fibre lasers due to their unique optical properties. Fluoride fibres, composed of materials such as ZBLAN, offer superior transmission across a broad range of wavelengths, including the mid-infrared spectrum, where traditional silica fibres fall short. Low phonon energy reduces non-radiative losses, which is crucial for efficient laser operation and high output power. Additionally, the reduced multiphonon absorption in fluoride fibres allows for bet er laser beam quality and more stable operation in the visible range. These at ributes have led to advancements in laser technologies used in various applications, from medical devices to telecommunications, by improving efficiency, broadening the operational wavelength range, and enhancing overall performance. We have a range of projects with industrial and academic collaborators in Australia and Europe to study new laser architectures. Projects will include developing new laser sources capable of delivering high-power and broadband pulses (supercontinuum), ultra-short pulses in the mid-IR region, or visible (yellow) mode-locked pulses through advanced dispersion compensation schemes, multi-wavelength pumping schemes, and improved fibre-compatible components.

Claude Aguergaray
Stephane Coen
Miro Erkintalo

Fields of research: Physical sciences; Atomic, molecular and optical physics; Photonics, Optoelectronics, and optical communications

Measuring Flow Using Optical Coherence Tomography

Measuring flow using optical coherence tomography to map vasculature.

Optical coherence tomography (OCT) is a real time, non-invasive and non-contact imaging modality for translucent and transparent tissue capable of providing morphological images at the micron scale resolution at more than 1mm depth penetration. First developed in 1991 for measuring the human retina, OCT's fields of application have been extended to a wide variety of tissues and non-biological structures. In addition, by extracting the phase of the signal, flow can be measured using the Doppler shift. We have a range of projects with clinical collaborators to study samples like the inner ear and the lymphatics. Projects will include components of data processing and machine learning or optical designs and will make use of the existing OCT systems in the biophotonics laboratory in the Physics Department at the University of Auckland. These projects are also part of the overall research programme of the Dodd-Walls Centre for Photonic and Quantum Technologies and the Transdisciplinary Biophysical Imaging Centre.

Biophotonics New Zealand

Frederique Vanholsbeeck
Marco Bonesi

Fields of research: Physical sciences; Molecular and optical physics; Nonlinear optics and spectroscopy

Combining Optical Coherence Tomography and Vibrational Spectroscopy

Combining optical coherence tomography (OCT), a real time, non-invasive and non-contact structural imaging modality with vibrational spectroscopies that allows analysis of the biochemical content of the sample to obtain structural and biochemical information. We have a range of projects with industrial and clinical collaborators to study samples like the inner ear, articular cartilage, brain tumours and the impact of diseases and climates on crops.

Optical coherence tomography (OCT) is a real time, non-invasive and non-contact imaging modality for translucent and transparent tissue capable of providing morphological images at the micron scale resolution at more than 1mm depth penetration. Vibrational spectroscopies allow for the biochemical content of the sample to be analysed. Therefore, combining both techniques gives structural and biochemical information. We have a range of projects with industrial and clinical collaborators to study samples like articular cartilage, brain tumours and the impact of diseases and climates on crops. Projects will include components of data processing and machine learning or optical designs and will make use of the existing OCT systems and the spectrometers based in the biophotonics laboratory and the Photon Factory in Auckland. Some projects will require the design of miniprobes that incoporate several techniques. These projects are also part of the overall research programme of the Dodd-Walls Centre for Photonic and Quantum Technologies and the Transdisciplinary Biophysical Imaging Centre.

Biophotonics New Zealand

Frederique Vanholsbeeck
Cushla McGoverin
Marco Bonesi
Claude Aguergaray

Fields of research: Physical sciences; Molecular and optical physics; Nonlinear optics and spectroscopy

Multimodal Imaging to Study Bacteria and Biofilm

Optical tweezers use highly focused light to manipulate tiny particles. The Biophotonics laboratory in the Physics Department is developing optical tweezers for the manipulation of bacteria or cells. The tweezers include modules for fluorescent microscopy, force measurement and trap shaping. In addition, we have developed optical coherence tomography systems to measure rheological properties of viscous fluid. These will be used in combination to characterise the fluorescence of new and existing bacterial viability dyes on a single bacterium basis and to measure the properties of biofilm.

Biophotonics New Zealand

Frederique Vanholsbeeck
Cushla McGoverin
Marco Bonesi

Fields of research: Physical sciences; Biological sciences; Molecular and optical physics; Nonlinear optics and spectroscopy; Microbiology; Bacteriology

Computational Simulations in Material Physics

We investigate electronic and thermodynamic material properties as a function of size, from clusters of a few atoms to nanoparticles and bulk materials by means of varied quantum-mechanical techniques.

1. Monte Carlo melting simulations of noble gases in extreme conditions characterized by GPa pressures and strong magnetic fields as found on magnetic white dwarfs. Can helium or neon condense into a 2-dimensional graphene-like solid?
2. Method development to study high-pressure phase transitions in search of new materials (thermodynamical simulations based on machine-learning potentials) to give insight into diamond-anvil cell experiments.
3. Quantum Monte Carlo simulations of mixed bosonic-fermionic systems like the extended Bose-Hubbard model or polaron problem with the aim to get insight into/discover new quantum phase transitions.
4. First principles simulations of the structure of liquid metals and their dilute alloys, and structure formation within these liquid systems.
5. Liquid metallic alloys for catalysis and energy applications (e.g. carbon dioxide conversion).
6. Electronic structure of superatoms as a starting point for the design of nanostructured materials.
7. Kinetic Monte Carlo simulations of electronic transport in nanostructured materials.

Elke Pahl
Nicola Gaston

Fields of research: Physical Sciences; Chemical Sciences; Condensed mat er physics; Quantum physics; Condensed mat er modelling and density functional theory; Structural properties of condensed mat er; Surface properties of condensed mat er; Theoretical and computational chemistry; Computational chemistry; Statistical mechanics in chemistry

Dynamic Microfluidics Laboratory

Studying the interactions of fluids with materials at small length scales: droplets, nanoconfined fluids, and advanced colloids. This research is broad and interdisciplinary, encompassing both theoretical and experimental work.

Main themes for research projects include:

1. High-speed photography of droplets: raindrops to coatings, ink-jets to sprinklers, ferrofluids to dairy products – we study processes in which drops land or spread, often in contact with interesting surfaces.
2. Nanofluidics, particularly the flow of fluids, particles and ions through the confined entrances of nanoscale pores and pipet es. This research supports new, efficient methods for sensing, analysis and manipulation of nanoscale colloids, including various interesting bioparticles.
3. Advanced colloids such as Janus spheres, which are micro- and nanoscale colloids with some asymmetry in their physical and/or chemical properties. Asymmetric particles (such as Janus spheres) are increasingly of interest because of their possible uses as building blocks for new self-assembled and even reconfigurable materials. More broadly, we can use the tools of soft condensed mat er to study large collections of asymmetric particles.

Our team has a diverse mix of backgrounds in physics, chemistry, engineering, materials science and nanotechnology.

Fluidics at Small Scales

Geoff Willmot

Fields of research: Physical sciences; Chemical sciences; Condensed mate r physics; Fluid mechanics and thermal engineering; Soft condensed mat er; Microfluidics and nanofluidics; Physical chemistry; Colloid and surface chemistry

Nonlinear Photonics in Laser-Driven Resonators

This project experimentally, numerically, and theoretically explores the physics and applications of nonlinear optical resonators driven with coherent laser light.

Nonlinear optical resonators driven with coherent laser light display incredibly rich physics and they have a host of applications. Of particular interest is the fact that continuous wave laser light coupled into resonators with a Kerr-type nonlinearity can spontaneously transform into a train of ultrashort pulses of light. In the frequency domain, this remarkable transformation manifests itself as the generation of an optical frequency comb that is made up of hundreds or thousands of equally-spaced frequency components – each an ultra-stable laser in its own right. Over the last decade, the resultant "Kerr frequency combs" have enabled countless breakthroughs in applications ranging from telecommunications to distance measurements.

This project will experimentally, theoretically, and numerically examine the physics and applications of coherently driven Kerr resonators. The particular focus will be on exploring new operating regimes and paradigms for creating ultrashort pulses and frequency combs with desired characteristics. Platforms considered will include both resonators made from optical fibre as well as integrated resonators fabricated on photonic circuits.

Laser Lab

Miro Erkintalo
Stuart Murdoch
Stephane Coen

Funding: Scholarship from project

Fields of research: Physical sciences; Engineering; Atomic, molecular and optical physics; Photonics, optoelectronics and optical communications; Nonlinear optics and spectroscopy; Lasers and quantum electronics

Developing Optical Coherence Tomography Tools

Developing optical coherence tomography (OCT) tools to add functional information to the high resolution structural images. We develop optical biopsies using OCT and new contrast agents such as birefringence, mechanical compression, chromatic dispersion and elastography. We have a range of projects with industrial and clinical collaborators to study samples like the inner ear, articular cartilage and the impact of botrytis on grapes.

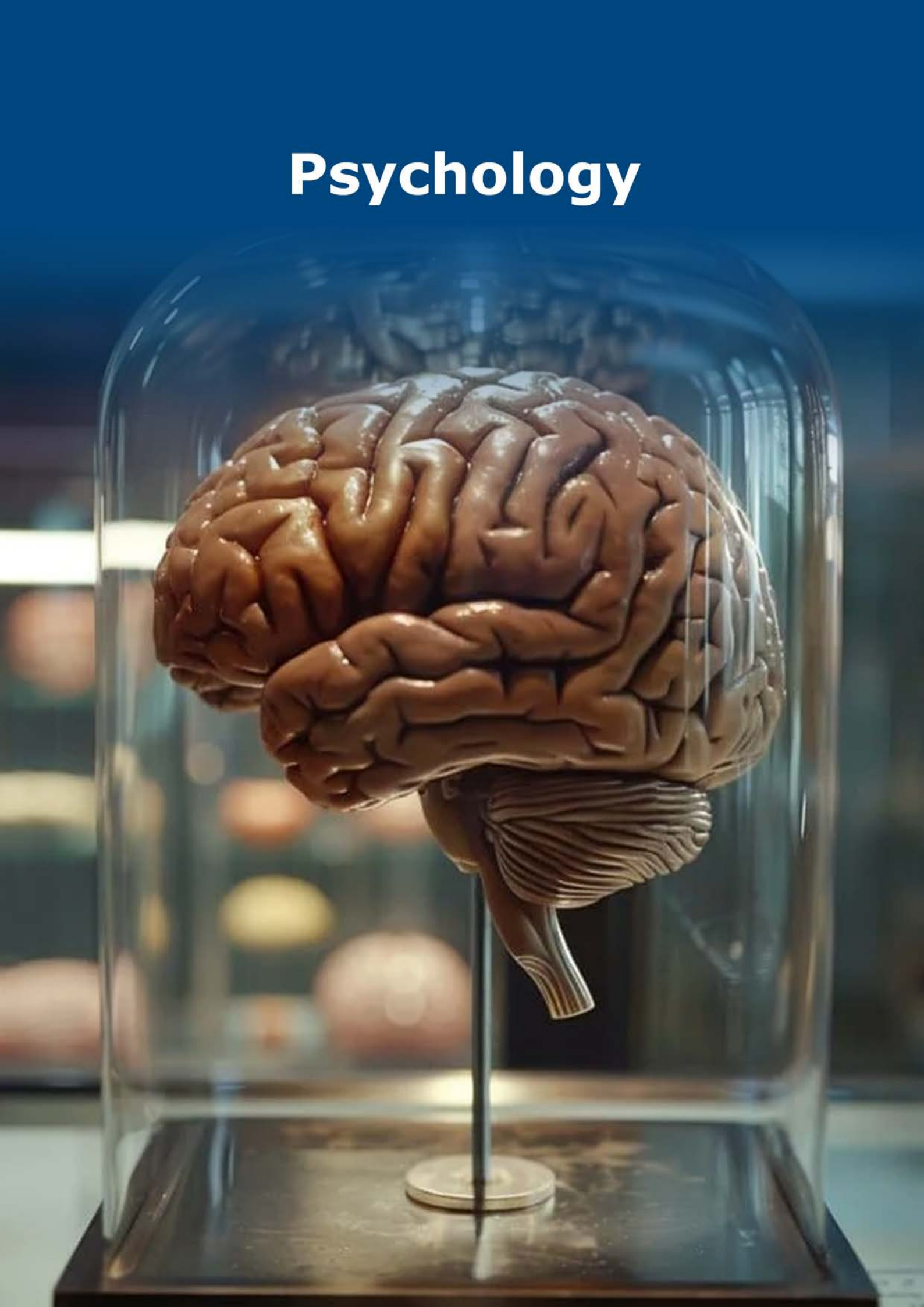
Optical coherence tomography (OCT) is a real time, non-invasive and non-contact imaging modality for translucent and transparent tissue capable of providing morphological images at the micron scale resolution at more than 1mm depth penetration. First developed in 1991 for measuring the human retina, OCT's fields of application have been extended to a wide variety of tissues and non-biological structures. Conventional OCT is based on measuring the back reflection of light induced by changes in the refractive index in the sample. Although the information gained from purely structural images is high, poor contrast can make structures difficult to identify. Therefore, OCT was extended to exploit other light properties for bet er contrast and quantitative measurements. In this context, we develop optical biopsies using OCT and new contrast agents such as birefringence, mechanical compression, chromatic dispersion and elastography. We have a range of projects with industrial and clinical collaborators to study samples like the impact of botrytis on grapes. Projects will include components of data processing and machine learning or optical designs and will make use of the existing OCT systems based in the biophotonics laboratory in the Univerity of Auckland. These projects are also part of the overall research programme of the Dodd-Walls Centre for Photonic and Quantum Technologies and the Transdisciplinary Biophysical Imaging Centre.

Biophotonics New Zealand

Frederique Vanholsbeeck
Marco Bonesi

Fields of research: Physical sciences; Molecular and optical physics; Nonlinear optics and spectroscopy

Psychology



Our Voices

Our research aims to better understand the diverse and complex journey our young people experience growing up in Aotearoa to inform policy and services targeted to supporting their wellbeing.

Research exploring child and youth wellbeing is limited by measures frequently derived from deficit-based, adult-centric, unidimensional data lacking a cultural lens. The Our Voices project sought to address some of these limitations by codesigning an app with young people to collect their own multimodal, qualitative views of wellbeing. The goals of the project are to make sense of young people's understandings of wellbeing and to explore the methodological possibilities of working with such a novel and complex dataset.

Given the large-scale nature of the data (almost 1000 participants), there are several possible thesis projects that would align with the Our Voices goals. Projects could span one or more areas of wellbeing and/or utilise different research methodologies, such as thematic analysis or machine learning to make sense of youth experiences.

Potential projects include a focus on:

- emotional pat erns of young people over time
- challenges and highlights of the transition to high school
- experiences of how wellbeing captured by the Our Voices project align with earlier indicators and determinants of wellbeing.

Our Generation, Our Voices, All Our Futures

Kane Meissel
Georgia Rudd
Pat Bullen
John Fenaughty

Funding: Scholarship from project

Project open until: January 2025

Fields of research: Psychology; Education; Educational psychology; Other education not elsewhere classified

Innovating Mental Health Support with Headstrong

Join our multidisciplinary team to innovate and enhance Headstrong, a mental health chatbot for youth. Several projects are available focused on content creation, evaluation, cultural adaptations, and advanced use of AI.

Join a cutting-edge, multidisciplinary team working on Headstrong, an innovative, award winning chatbot designed to support young people's mental health and well-being. Headstrong (headstrong.org.nz) is a real-world app, funded by the New Zealand Government, and is available free to users across the country. With over 100 skills to manage mood, stress, cultural identity, addiction issues, and physical exercise, we constantly iterate to ensure the tool meets the evolving needs of its users.

We have a range of research projects available. These could include creating and testing new bespoke content for issues like relationships, conflict, sleep, and anger management, or testing existing content in various populations, such as school settings or clinical contexts. There are also opportunities for cultural adaptations, translations into other languages, and exploring enhanced AI capabilities compared to the existing system.

If you have a passion for digital innovation, a keen interest in youth mental health, and a curious mind, please get in touch. We would love to discuss how you can contribute to a project that will make a real-world impact and improve the lives of young people.
headstrong.org.nz or check out our socials @headstrongNZ

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