2026 QANZIAM Conference

Tuesday, June 2

Griffith University
Nathan Campus (Brisbane South Campus)

Keynote Speakers

Professor Roslyn Hickson (JCU & CSIRO)   Dr Ryan Heneghan (Griffth)

Conference Overview

90 Attendees   34 Contributed Talks   4 Parallel Sessions

Registration

Registration will open at 8:30am. Please make your way to N16_0.03 (Building N16, Level 0, Room 0.03). A campus map is included on the next page.

If you are making your way to registration from either East Car Park or the bus stop, please follow the below directions.

- Walk along South Ring Road until you reach the pedestrian crossing directly outside N54 (approximately G2 on the campus map).
- Turn right and walk down the stairs outside N54.
- Walk to Campus Heart Plaza by following the path straight ahead.
- When you reach Cafe Rosa (N76), walk down the stairs and N16_0.03 will be on your right.

Buses to Griffith

There are many buses that stop at Griffith University. Most buses stop on South Ring Road (approximately J2 on the campus map).

Parking at Griffith

Single day parking is available in **East Car Park** (far right of the map above N38). Parking on Nathan campus is NOT free. Payment for parking can be made via the PayStay app or at pay-by-plate machines. The pay-by-plate machine nearest to East Car Park is on South Ring Road at approximately P6 on the campus map. The cost is $2 per hour or $6 for the day.

See below link for additional information on casual parking at Griffith (pay-by-plate machines or using the PayStay app). https://www.griffith.edu.au/transport/parking/paying-for-parking/casual-parking

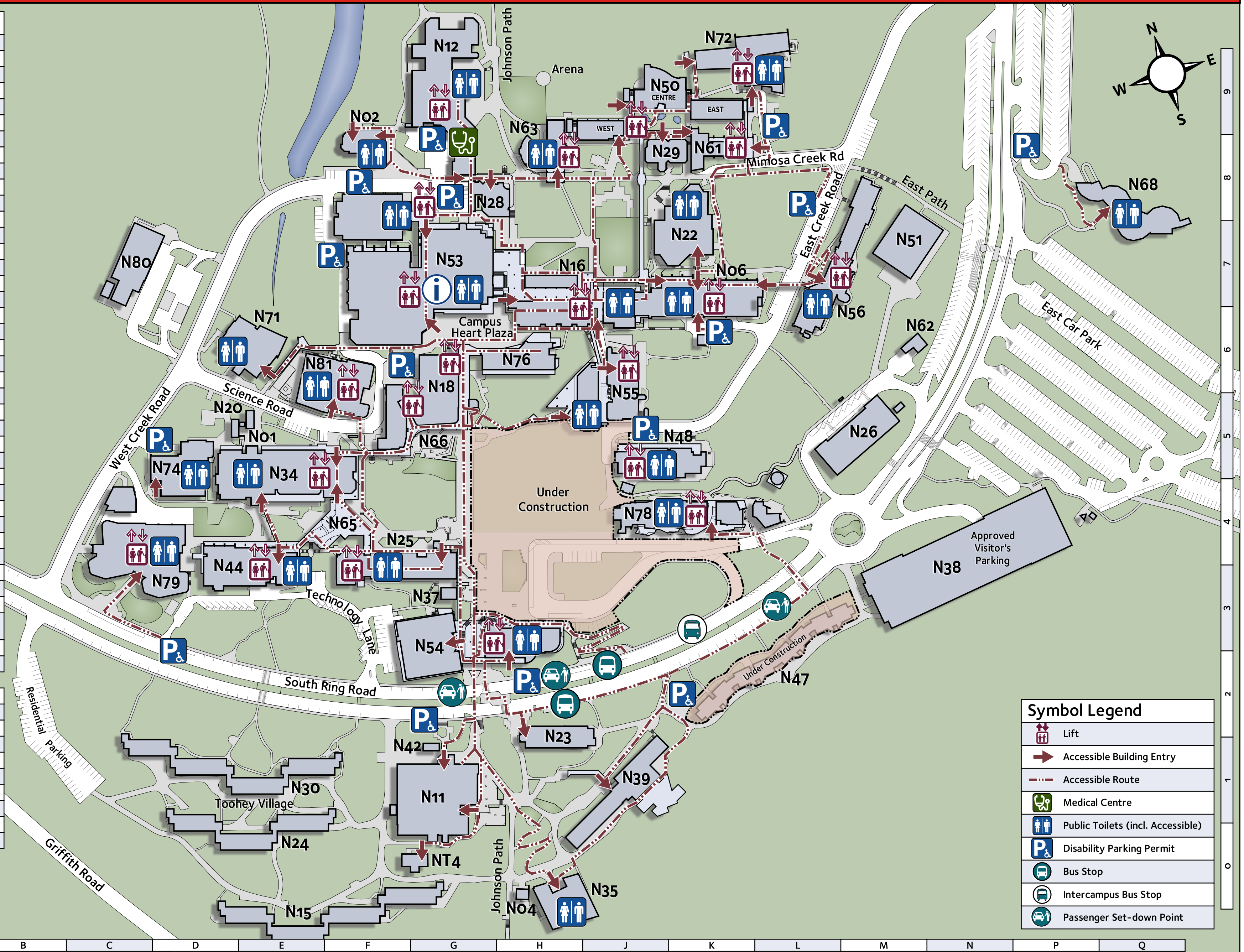
GriffithUNIVERSITY

Brisbane South (Nathan) - Mobility Map

Building Legend

N02	Cinema	F8
N06	Patience Thoms	K7
N11	The Hub	G1
N12	Sewell	G9
N15	Barakula	E0
N16	Macrossan	H6
N18	Central Theatres	G5
N22	Northern Theatres 1&2	K7
N23		H1
N24	Girraween	E0
N25	Science 1	F3
N28	Student Association and Clubs	G8
N29	Northern Theatres 3, 4 & 5	J8
N30	Kinaba	D1
N34	Science 2	E4
N35	Multi-Faith Centre	H0
N38	Ridge Car Park	N3
N39	Bellenden Ker	J1
N44	Technology	E3
N47	Carnarvon	L2
N48	Health Sciences	K5
N50	Business 1	J9
N53	Willett Centre	F7
N54	Bray Centre	G2
N55	Environment 1	J5
N56		L7
N61	Law	K8
N63	Business 3	H8
N65	Science Link & Common Room	F4
N66	Community Centre	F5
N68	Eco Centre	Q8
N71	Uni Bar and Function Centre	D6
N72	Glyn Davis Building	L9
N74	Queensland Microtechnology Facility	D4
N76	Campus Heart	H6
N78	Sir Samuel Griffith Centre	K4
N79	Henry Smerdon Engineering, Technology and Aviation	C3
N81	Environmental Laboratories Building	E5
NT4	Accommodation Annexe	G0

Service Buildings		
N01	Dangerous Chemicals Store	D5
N04	Pump House	H0
N20	Flammable Liquid Store	D5
N26	Maintenance	M5
N37	Substation S2	G3
N42	Substation S9	G1
N51	University Store	M7
N62	Compound	M6
N80	Chiller Plant West	C7



Symbol Legend

Lift	
Accessible Building Entry	
Accessible Route	
Medical Centre	
Public Toilets (incl. Accessible)	
Disability Parking Permit	
Bus Stop	
Intercampus Bus Stop	
Passenger Set-down Point	

March 2026

Schedule: N16_0.03 (Building N16, Level 0, Room 0.03)

Time	Speaker	Title
08:30 – 09:00		Registration
09:00 – 09:20	Welcome	Conference officially opened by Professor Fran Sheldon, Head of the School, School of Environment and Science, Griffith University
09:20 – 09:30		10 minute break to move to parallel sessions
09:30 – 09:50	Max Auer	*Session Chair: Luz Pascal* Less is More: Why Ignoring Data Can Improve Models
09:50 – 10:10	Joseph Wilson	Is the Last Layer Sufficient for Uncertainty Quantification?
10:10 – 10:40		Morning Tea
10:40 – 11:00	Jiamin Xu	*Session Chair: Nina Rynne* Robust Bayesian Inference for ODE models using Energy Score Informed Power Posteriors
11:00 – 11:20	Jamintha Samarakoon	Bayesian Spatial Framework for Quantifying Uncertainty in Labour Market Delineation
11:20 – 11:30		10 minute break to move to keynote
11:30 – 12:30	**Keynote Speaker** Roslyn Hickson	*Session Chair: David Harman* From the whiteboard to the room where it happens: industrial mathematics in public health
12:30 – 13:40		Lunch
13:40 – 14:40	**Keynote Speaker** Ryan Heneghan	*Session Chair: Mike Bode* Reduced-complexity emulation of global marine ecosystem models
14:40 – 14:50		10 minute break to move to parallel sessions
14:50 – 15:10	Vanessa Lopez	*Session Chair: Mike Bode* Artificial Intelligence for Sustainable Crop Management under Uncertainty
15:10 – 15:30	Sithara Wijekoon	Data Fusion using Vine Copula-based Imputation
15:30 – 16:00		Afternoon Tea
16:00 – 16:20	Jiading Liu	*Session Chair: Indu B Wadhawan* Kernel-based learning of Green's Functions via Random Features
16:20 – 16:40	Matt Moores	Forecasting as a Service: Integrating Large Language Models with Time Series Predictions
16:40 – 17:00	Mildred Mmbone	Stable Interaction Rule Discovery in Random Survival Forests for Censored Survival Data
17:00 – 17:20		Close of conference

Schedule: N16_0.06 (Building N16, Level 0, Room 0.06)

Time	Speaker	Title
08:30 – 09:00		Registration
09:00 – 09:20	Welcome	Please join N16_0.03
09:20 – 09:30		10 minute break to move to parallel sessions
		Session Chair: Jack Fenwick
09:30 – 09:50	Zachary J Wegert	Multi-domain shape calculus via level-set dilation
09:50 – 10:10	Patrick Hassard	Dual-scale modelling of two-dimensional flow in locally-periodic porous media
10:10 – 10:40		Morning Tea
		Session Chair: Shahak Kuba
10:40 – 11:00	Sakshi Jain	Optimal responses to randomness - Control in complex stochastic systems
11:00 – 11:20	Tran Nguyen Tung Doan	A Globally Convergent Minorization -Maximization Algorithm for Softmax-gated Gaussian Mixture of Experts Models
11:20 – 11:30		10 minute break to move to keynote
11:30 – 12:30	**Keynote Speaker** Roslyn Hickson	Please join N16_0.03
12:30 – 13:40		Lunch
13:40 – 14:40	**Keynote Speaker** Ryan Heneghan	Please join N16_0.03
14:40 – 14:50		10 minute break to move to parallel sessions
		Session Chair: Patrick Grant
14:50 – 15:10	Sadegh Derakhshan	Hydrodynamics of the Fitzroy River Estuary
15:10 – 15:30	Connor O'Reilly	Local Monitoring in Networked Public Goods Games
15:30 – 16:00		Afternoon Tea
		Session Chair: Samuel Stephen
16:00 – 16:20	Nina Rynne	Using optimal control to forecast temperature overshoot outcomes
16:20 – 16:40	Available	
16:40 – 17:00	Available	
17:00 – 17:20		Close of conference. Please join N16_0.03

Schedule: N16_0.08 (Building N16, Level 0, Room 0.08)

Time	Speaker	Title
08:30 – 09:00		Registration
09:00 – 09:20	Welcome	Please join N16_0.03
09:20 – 09:30		10 minute break to move to parallel sessions
09:30 – 09:50	Mike Bode	*Session Chair: Morenikeji Deborah Akinlotan* Dynamical systems models should not be used in applied ecology
09:50 – 10:10	Upayan Roy	Effect of Optimistic-Pessimistic Biased Environmental Perception in Evolutionary Games
10:10 – 10:40		Morning Tea
10:40 – 11:00	Owen Stewart	*Session Chair: Max Auer* Guiding Great Barrier Reef conservation with a hybrid machine learning model of an irruptive pest species
11:00 – 11:20	Tapash Alister	Is bigger better? Analyzing the trade-off between management area and management intensity in conservation planning
11:20 – 11:30		10 minute break to move to keynote
11:30 – 12:30	**Keynote Speaker** Roslyn Hickson	Please join N16_0.03
12:30 – 13:40		Lunch
13:40 – 14:40	**Keynote Speaker** Ryan Heneghan	Please join N16_0.03
14:40 – 14:50		10 minute break to move to parallel sessions
14:50 – 15:10	Luz Pascal	*Session Chair: Joseph Wilson* Using the value of information for making better decisions
15:10 – 15:30	Jordan Holdorf	Diversification vs. Concentration: Optimal Restoration Investment under Climate Risk
15:30 – 16:00		Afternoon Tea
16:00 – 16:20	Adarshkrishnan Rajakumar	*Session Chair: Zachary J Wegert* Data requirements for accurate extinction-risk prediction in bistable populations
16:20 – 16:40	Amanda Salpadoru	Profile-wise analysis of potentially bistable ecosystems
16:40 – 17:00	Jordan McGrath	Modelling the change in Queensland human and estuarine crocodile interaction risk from 2021 to 2046
17:00 – 17:20		Close of conference. Please join N16_0.03

Schedule: N16_0.10 (Building N16, Level 0, Room 0.10)

Time	Speaker	Title
08:30 – 09:00		Registration
09:00 – 09:20	Welcome	Please join N16_0.03
09:20 – 09:30		10 minute break to move to parallel sessions
09:30 – 09:50	Mason Lacy	*Session Chair: Zoltan Neufeld* Uncovering the T cell differentiation pathway
09:50 – 10:10	Yuuka Foo	Modelling the Evolution of Mechanical Stress in Epithelial Tissues
10:10 – 10:40		Morning Tea
10:40 – 11:00	Georgia Weatherley	*Session Chair: Nathan Garland* Mass-conserving boundary motion in a model of invasion and recession
11:00 – 11:20	David Harman	Redesigning a foundation mathematics course to promote mathematical competency
11:20 – 11:30		10 minute break to move to keynote
11:30 – 12:30	**Keynote Speaker** Roslyn Hickson	Please join N16_0.03
12:30 – 13:40		Lunch
13:40 – 14:40	**Keynote Speaker** Ryan Heneghan	Please join N16_0.03
14:40 – 14:50		10 minute break to move to parallel sessions
14:50 – 15:10	Holly Baldock	*Session Chair: Sakshi Jain* Revisiting the access conductance of a nanopore in a charged membrane
15:10 – 15:30	Shahak Kuba	Revisiting the continuum limit of a free boundary model of mechanical cell interactions
15:30 – 16:00		Afternoon Tea
16:00 – 16:20	Jack Fenwick	*Session Chair: Meagan Carney* A mathematical model of osteocyte network growth
16:20 – 16:40	Huan Zhou	Biologically Guided Machine Learning Approaches for Long COVID Classification
16:40 – 17:00	Lauren Deegan	What happens to ecosystems when we remember evolution?
17:00 – 17:20		Close of conference. Please join N16_0.03

Keynote Speakers

From the whiteboard to the room where it happens: industrial mathematics in public health

Professor Roslyn Hickson

James Cook University and CSIRO

Abstract: Industrial mathematics promises to solve real problems for real clients. But what does that promise actually require of us as mathematicians, and how does the nature of that engagement shape the mathematics itself?

This talk traces an evolving philosophy of collaboration, from my own early experience of taking a problem away and not finding my way back to the end user, through to deeply embedded, continuously iterative partnerships that now influence not just the modelling but the field experiments and laboratory work feeding into it. I will draw on projects spanning steel manufacturing, tuberculosis control in the Torres Strait, dengue forecasting, malaria elimination, and current mosquito control programs, where we work alongside a multitude of disciplines and stakeholders.

I will argue that the distance between you and the end user is not merely a communication problem; it is a mathematical one. The questions worth asking, the model complexity that is justified, the uncertainty that must be quantified, and the outputs that are actually interpretable all depend on sustained engagement with the people who will use your work. That said, not every problem is ready for end-user partnership, and I will also reflect on where more foundational mathematical development is the right first step.

Bio: Professor Roslyn Hickson is the joint CSIRO and James Cook University Science Leader for Emerging Infectious Diseases. Her research focuses on informing policy and practice through the mathematical modelling of infectious diseases. Her work spans tuberculosis control, dengue and Wolbachia interventions, influenza, and malaria elimination across the Asia-Pacific, producing tools now used by governments and international partners. She is the inaugural recipient of the 2026 ANZIAM KA Landman Medal for Contributions to Industrial Mathematics.

Reduced-complexity emulation of global marine ecosystem models

Dr Ryan Heneghan

Griffith University

Abstract: The impacts of climate change and fishing on marine ecosystems are global in extent and growing in magnitude. Global-scale models are required to fully capture and manage their combined, interactive impact on marine ecosystems. These models provide a scientific basis for long-term, strategic policy-making around best use of marine resources across international and environmental boundaries. However, global marine models are severely limited by high operational costs, in some cases taking days to complete a simulation even with high performance computing. Here, I will discuss the rise of reduced-complexity emulators to tackle these prohibitive costs. I will outline the recent development of a reduced-complexity emulator of a published global marine model, its advantages and limitations, and its potential to massively amplify the reach of past, present and future global marine model development and application. This presentation will highlight the powerful role of model emulation for human impact assessment.

Talk Abstracts

All abstracts are in alphabetical order (by first name).

Data requirements for accurate extinction-risk prediction in bistable populations

Adarshkrishnan Rajakumar
Supervisors/Collaborators: Professor Matthew J. Simpson and Associate Professor Pascal R. Buenzli
Queensland University of Technology

Understanding and predicting extinction risk is a central challenge in population biology. Mathematical models incorporating Allee thresholds are commonly used to understand population dynamics, and to assess extinction risks. Inaccurate predictions can have serious consequences for conservation management. In this simulation study we develop a likelihood-based inference and prediction workflow to estimate parameters, including the Allee threshold and population diffusivity, using noisy count data generated using a well-defined discrete model. Although parameters can appear to be identifiable, the accuracy of resulting predictions depends strongly on the quantity, quality, and spatial resolution of the data. These results demonstrate that seemingly reliable parameter estimates can lead to inaccurate predictions, highlighting the need for careful consideration of data quality and quantity to guide extinction-risk modelling and prediction.

Profile-wise analysis of potentially bistable ecosystems

Amanda Salpadoru
Supervisors/Collaborators: Dr. David J. Warne, Dr. Matthew P. Adams, Prof. Kate Helmstedt
Queensland University of Technology

Ecological regime shifts describe sudden transitions between ecosystem states that occur when critical thresholds are exceeded. Some ecosystems exhibit bistability, where two alternative stable states coexist under the same environmental conditions, while monostable systems possess only a single stable equilibrium. Predicting such transitions is challenging because parameter uncertainty can obscure the underlying stability regime and associated tipping points. Using lake eutrophication and predator–prey dynamics as examples, we develop a profile-wise stability analysis framework that combines profile likelihood methods with dynamical systems analysis. Our results show that standard monitoring data are often insufficient to distinguish bistable from monostable regimes, with tipping points becoming practically identifiable only when observations are collected close to the critical transition. We further demonstrate that collapse and recovery thresholds can differ substantially between stability regimes. These findings highlight the importance of accurately identifying ecological stability regimes, as incorrect threshold estimation may cause ecosystems to cross critical transition points earlier than expected after which recovery may become difficult or irreversible.

Local Monitoring in Networked Public Goods Games

Connor O'Reilly
Collaborators: Dr Maria Kleshnina (School of Mathematical Sciences - QUT) and Dr Manuel Staab (School of Economics - UQ)
Queensland University of Technology

Networks play a central role in shaping incentives for cooperation in economic and social systems, yet the mathematical foundations linking network structure to the sustainability of cooperative behaviour remain only partially understood. This project aims to investigate these mathematical foundations under both global and local monitoring within a networked public goods game. In the context of public goods games, global monitoring means that every player knows about the past actions of every other player, whereas this knowledge is restricted to only a player's neighbours under local monitoring. The project simulates a stage payoff model for a public goods game played on large random networks to demonstrate how networks' spectral properties alter both the overall welfare generated by the network, and each player's likelihood of cooperating in the game. By calculating stage payoffs, we can gain an understanding of which network structures and endowment distributions can sustain cooperation while providing optimal welfare. This research demonstrates that it is hierarchical network structures that maximise generated welfare while best facilitating cooperation between players. Furthermore, assigning endowment distributions that reflect the asymmetric nature of the network will further contribute to cooperative behaviours and welfare maximisation regardless of the network's structure. It is found that the optimal endowment distribution is proportional to the network's Perron eigenvector, and cooperativeness within the network is determined by its Perron eigenvalue. This project to date has focused on the stage payoff model under global monitoring, and will pivot into exploring the same effects under a new local monitoring model. The project will also continue the investigation surrounding the links between networks' spectral properties and cooperative outcomes by investigating degree bounds of different types of random networks to produce similar bounds on cooperativeness.

Redesigning a foundation mathematics course to promote mathematical competency

David Harman
Griffith University

Students often enter university without the mathematical knowledge and skills required to succeed in first-year mathematics courses, particularly following the removal of mathematical prerequisites from many degree programs. 1017SCG Foundation Mathematics was introduced to support students who did not successfully complete Mathematical Methods (or an equivalent subject) in high school and require additional preparation before undertaking university-level mathematics. A key challenge in the course was encouraging students to focus on developing mathematical confidence and competency rather than simply achieving a passing grade. As convenor of 1017SCG Foundation Mathematics, I redesigned the course to include pass/fail grading and opportunities to re-attempt failed assessment items. These changes were intended to shift students' focus from obtaining enough marks to pass towards mastering foundational mathematical concepts, while reducing assessment anxiety and better preparing students for future study. This presentation discusses the rationale behind these changes, their implementation, and the lessons learned from redesigning a large foundation mathematics course to better support student learning and preparedness.

Mass-conserving boundary motion in a model of invasion and recession

Georgia Weatherley
Supervisors/Collaborators: Adrianne L. Jenner, and Michael C. Dallaston
Queensland University of Technology

In multiple sclerosis patients, immune cells attack myelinated nerve axons, creating demyelinated regions called lesions. MRI observations show that individual lesions can grow or shrink over time. These lesion dynamics provide important insights into disease progression, as well as the efficacy of treatment. We develop a moving boundary model to represent lesion boundaries as sharp interfaces that can advance or recede. Existing moving boundary extensions of reaction–diffusion equations, such as the Fisher–KPP equation, typically use a Stefan-like condition in which boundary motion is determined by the flux of cells. Instead, we model the boundary velocity as a function of local cell density, allowing us to represent biological processes where cells degrade or deposit material to move a boundary without being consumed. We observe a variety of behaviours depending on the parameterisation of the boundary velocity function, including regimes supporting multiple invading and receding travelling waves, unstable travelling waves, and receding solutions with population blow-up.

Revisiting the access conductance of a nanopore in a charged membrane

Holly Baldock
Supervisors/Collaborators: David Huang (Adelaide University)
University of Queensland

Electric-field-driven electrolyte transport through nanoporous membranes is important for applications including osmotic power generation, sensing and iontronics. We derive a simple theory for the electric-field-driven electric current through a pore in an ultrathin membrane for arbitrary surface potentials, which predicts scaling with fractional powers of the pore size and Debye length. These results are in line with scaling laws that we have derived previously for concentration-gradient-driven electrolyte transport through a two-dimensional membrane.
We show that our theory accurately quantifies the ionic conductance through an ultrathin membrane in finite-element method numerical simulations for a wide range of parameters, and generalizes a widely used theory for the access electrical conductance of a membrane nanopore to a broader range of conditions. Our theory predicts that fractional scaling of the ionic conductance with electrolyte concentration at low concentrations is an intrinsic property of charged ultrathin membranes and can be observed in thicker membranes that are ion-selective, which could help to explain experimental observations of this widely debated phenomenon.

Biologically Guided Machine Learning Approaches for Long COVID Classification

Huan Zhou
Supervisors/Collaborators: Meagan Carney, Kirsty Short and Keng Chew
University of Queensland

Long COVID is associated with subtle biological changes that are often difficult to detect using standard clinical testing. Proteomic profiling and machine learning methods were used to explore protein patterns associated with Long COVID. Differential expression analysis, batch correction, and biologically guided feature selection were combined with machine learning methods to explore protein patterns associated with Long COVID. Preliminary results suggested that incorporating biological evidence into feature selection improved classification performance.

A mathematical model of osteocyte network growth

Jack Fenwick
Supervisors/Collaborators: A/Prof. Pascal Buenzli, A/Prof. Vivien Challis, Dr Richard Weinkamer, Alexandra Tits
Queensland University of Technology

The osteocyte network is a spatial cellular network connected by dendritic cell protrusions whose structure is determined by the embedment of bone forming cells (osteoblasts) at the moving bone-forming surface. Network architecture is important for many bone functions, but little is known about how the network forms during bone growth. It has been suggested that osteoblast embedment may be controlled by connections between osteoblasts and the network. In this contribution, we develop a mathematical model of osteocyte network growth to explore how the regulation of osteoblast embedment by the existing osteocyte network may affect the development of the osteocyte network. We propose a novel, two dimensional agent-based model of osteocyte network growth. In this model, each osteocyte produces cell protrusions that are connected to other osteocytes in the network and osteoblasts in the bone surface, generating embedment signals. Embedding osteoblasts differentiate into osteocytes, thereby expanding the osteocyte network. The osteocyte networks produced by this model are analysed using a variety of geometric and network properties, such as betweenness centrality. We find that network architecture depends strongly on the type of embedment signals received by osteoblasts. Inhibitory embedment signals consistently produced qualitatively realistic osteocyte networks. Excitatory embedment signals produce networks with clusters of osteocytes, that are not observed experimentally.

Bayesian Spatial Framework for Quantifying Uncertainty in Labour Market Delineation

Jamintha Samarakoon
Supervisors/Collaborators: A/Prof Gentry White and Prof. Helen Thompson
Queensland University of Technology

Labour market delineation typically relies on deterministic regionalisation algorithms that treat commuting flows as fixed inputs and produce a single optimal partition. These approaches obscure uncertainty in boundary placement and cannot distinguish stable labour market cores from transitional regions where affiliation is ambiguous. We develop a Bayesian framework for quantifying uncertainty in labour market boundaries by integrating hierarchical Poisson spatial modelling of commuting flows with cohesion-based regionalisation. Commuting intensities are modelled using origin- and destination-specific socioeconomic covariates, distance, and conditional autoregressive (CAR) priors for spatially structured random effects. Posterior predictive commuting matrices are propagated through the Adaptive Simulated Annealing algorithm for Autonomous Labour Market Delineation, generating a distribution of regionalisations rather than a single partition. We introduce three complementary uncertainty measures: edge-level boundary probabilities, region-level membership stability, and local boundary pressure. Applied to Queensland, Australia, commuting data (520 regions), the framework identifies approximately 10

Kernel-based learning of Green's Functions via Random Features

Jiading Liu
Supervisors/Collaborators: Lei Shi, Hien Duy Nguyen, Xin Guo
University of Queensland

Partial differential equations (PDEs) are extensively used across diverse scientific and engineering disciplines due to their remarkable ability to model natural laws. It is well known that many linear PDEs have Green's function representations. In this talk, we introduce a novel data-driven kernel framework for learning Green's functions. The framework incorporates the random feature approach and can handle noisy, discretely observed functional data. We further provide rigorous theoretical guarantees for its performance.

Robust Bayesian Inference for ODE models using Energy Score Informed Power Posteriors

Jiamin Xu
Supervisors/Collaborators: Christopher Drovandi, Trung Tin Nguyen
Queensland University of Technology

We propose a robust Bayesian inference method for ordinary differential equation (ODE) models under model misspecification using energy score (ES) informed power posteriors. The temperature parameter is selected by minimising the energy score of the posterior predictive distribution, directly targeting predictive performance, and is implemented efficiently within a sequential Monte Carlo (SMC) framework. Theoretical results in a simplified Gaussian setting show that an appropriate temperature can outperform standard Bayes under misspecification. Experiments on simulated dynamical systems and a malaria transmission model demonstrate improved predictive accuracy and more reliable uncertainty quantification compared with standard Bayesian methods.

Diversification vs. Concentration: Optimal Restoration Investment under Climate Risk

Jordan Holdorf
Supervisors/Collaborators: Jordan Holdorf, Christopher Brown, Ivan Diaz-Rainey, Melanie Roberts
Griffith University

Nature markets are reshaping the financing of restoration and conservation projects by linking ecological outcomes, such as carbon sequestration, to financial returns. This presents both new opportunities and challenges for investment planning, requiring strategies that integrate ecological benefits with financial viability. To optimise outcomes in this dual context, decision frameworks must account for both temporal dynamics and spatial heterogeneity. Building on our previous work with a temporal optimisation model, we extend the framework to a spatio-temporal setting, incorporating site-specific costs, carbon sequestration rates, and exposure to stochastic climate events. Investment decisions are evaluated over a 25-year horizon using stochastic dynamic programming and solved via value iteration. In this presentation, we examine how spatial configuration influences both investment outcomes and the structure of optimal strategies. We show that accounting for spatial heterogeneity and correlated climate risk fundamentally changes investment behaviour: early stages favour diversification across sites, while later stages converge on smaller subsets of high-performing locations. Comparing alternative portfolio configurations reveals distinct regimes, including geographically distributed, clustered, and hybrid strategies that balance risk spreading with cost efficiency. These results demonstrate how spatial structure and uncertainty jointly shape adaptive investment decisions, highlighting the importance of integrated spatio-temporal modelling for designing financially viable and risk-aware restoration portfolios.

Modelling the change in Queensland human and estuarine crocodile interaction risk from 2021 to 2046

Jordan McGrath
Collaborators: Dr Ryan Heneghan and Professor Michael Bode
Griffith University

In Queensland recent state monitoring surveys estimate that estuarine crocodiles (Crocodylus porosus) have doubled in abundance since commercial hunting stopped in 1974. At the same time, human population growth is translating to denser and larger cities in northern and coastal Queensland, which is likely to increase the risk of adverse crocodile interactions - but by an unknown amount. Here, we project short term population growth of crocodiles under a scenario where populations have not yet reached carrying capacity. Combined with human projection data, we develop a risk function to estimate the change in local and aggregate encounter risk between humans and large crocodiles (greater than two meters) across Queensland from 2021-2046. Crocodile population growth is assumed to be linear due to an approximately linear historical trend observed across river systems in Queensland, and the absence of sufficient data to support more complex relationships. Results will help to inform management of the species and contribute to public awareness of place-based risks.

Is the Last Layer Sufficient for Uncertainty Quantification?

Joseph Wilson
Supervisors/Collaborators: Chris van der Heide, Liam Hodgkinson, Fred Roosta
University of Queensland

Epistemic uncertainty quantification (UQ) is important for safely deploying deep neural networks (DNN) in mission-critical settings. Many leading UQ methods first approximate a trained DNN by linearizing it, forming a Bayesian generalized linear model; a further practical approximation is to linearize around only the final layer to reduce computational cost. This last-layer approximation is commonly assumed to lose uncertainty information relative to full-network linearization. In this talk, we compare full-network and last-layer linearized models using random matrix theory, focusing on their predictive covariance structures. Our analysis suggests that, in the regimes considered, full-network linearization offers no clear theoretical advantage for epistemic UQ. Large-scale empirical results support this conclusion, with last-layer methods achieving comparable UQ performance at substantially lower computational cost.

What happens to ecosystems when we remember evolution?

Lauren Deegan
Supervisors/Collaborators: Dr Matthew Adams and Dr Maria Kleshnina
University of Queensland

Ecosystem network models can support environmental decision-making and conservation. An ecosystem network model describes a collection of species and forecasts how their populations change over a given time frame. It has been found that there is a limit to the number of species that such a model can represent as an ecologically stable system. It has been suggested that these models fail to incorporate the important role that evolution plays in ecosystem dynamics. There have been recent attempts to create network models that incorporate ecological processes as well as evolutionary processes (speciation). These models were observed to produce large, ecologically stable ecosystems. Despite their success, we propose that these models still fall short in their representation of evolution. It has been observed that when an individual evolves, they experience a cost or negative impact; this cost is referred to as an evolutionary trade-off. I will outline how evolutionary trade-offs can be incorporated into ecosystem network models and investigate the structures and behaviours that emerge in the resulting systems. We hope that this work will offer insights into the development of ecosystem models and how changes to assembly processes impact the systems that emerge, enhancing our understanding of ecosystem network models and bringing us closer to developing effective models that contribute to decision-making and conservation planning.

Using the value of information for making better decisions

Luz Pascal
Collaborators: Matt Holden
University of Queensland

From biodiversity conservation to climate change and epidemiology, modelling and simulation are essential tools for forecasting phenomena and simulating the effects of interventions. Using multiple models, where independent research teams design separate models, is a common method to improve the reliability of predictions, better capture uncertainty and support informed decisions. The intuition behind this approach is "the more models we have, the more reliable our predictions and thus our decisions". However, developing models is costly, time-consuming and may lead to diminishing returns. Decision-makers therefore face a difficult trade-off: should they invest their limited resources in developing more models (and risk delaying action), or should they embrace uncertainty and act with available information from existing models. In this talk, I will discuss how the value of information can guide modelling decisions and improve decision-making outcomes, through an example of epidemic management.

Uncovering the T cell differentiation pathway

Mason Lacy
Supervisors/Collaborators: Dr Adrianne Jenner, A/Prof Pascal Buenzli, Dr Yoav Binenbaum
Queensland University of Technology

Adoptive T cell therapy is a promising immunotherapy for treating cancer, leveraging the T cell's natural ability to kill cancer cells. A crucial step in this therapy involves the expansion of T cells ex vivo, however, it can be difficult to balance the desired amounts of memory, effector and dysfunctional T cell subtypes. Mathematical modelling of T cell expansion is a powerful tool that can be used to optimise expansion, assuming that the differentiation (to memory and effector) and dysfunction pathways are well-understood. Unfortunately, there is a large amount of uncertainty and disagreement in the literature describing the ways in which T cells differentiate to memory and effector cells, or become dysfunctional. I present one of the first large-scale mathematical investigations that aims to answer fundamental questions regarding T cell differentiation and dysfunction. Using observations from biological literature, we constructed a list of potential model features which inform the structure of an ordinary differential equation model. We compare all possible models (7,280 unique pathways) to data describing the ex vivo expansion of T cell subtypes, and we determine the most plausible features of the T cell differentiation and dysfunction pathways. This framework allows for a deeper understanding of T cell behaviour during immune responses which may be exploited to improve the administration of adoptive cell therapy.

Forecasting as a Service: Integrating Large Language Models with Time Series Predictions

Matt Moores
Collaborators: Rony Cheriyan
Technology One

Accurate forecasting is a longstanding challenge, but forecasts also need to be explainable for end-users to trust and act on them. This creates a persistent tension between the sophistication of the time series model and the difficulty for users with limited statistical training to comprehend. We address this gap by integrating a Large Language Model (LLM) to provide natural language explanations of forecasts. This talk will explore the practical trade-offs between two widely used forecasting models: ARIMA (AutoRegressive Integrated Moving Average) and the Prophet Generalized Additive Model (GAM). While ARIMA offers a principled statistical framework grounded in classical time series theory, the Bayesian curve-fitting approach of Prophet can better handle some of the idiosyncrasies of real-world datasets. Our web service is used for both predicting future values of the time series as well as counterfactual "what-if" hindcasts. This allows users to simulate hypothetical scenarios —such as the impact of staffing levels or a price change — to better understand the drivers of historical performance. Finally, we reflect on the engineering and mathematical lessons learned from deploying this service in a production Enterprise Resource Planning (ERP) platform: managing user expectations around forecast uncertainty, and the organisational dynamics of deploying mathematical models to non-technical audiences.

Less is More: Why Ignoring Data Can Improve Models

Max Auer
Collaborators: Tanja Schindler, Sixu Liu
University of Queensland

Extreme events dominate risk but break classical statistics. We show how trimming — removing the largest observations — restores stable behaviour for sums in dependent and heavy-tailed systems. Beyond robustness, trimming also provides a practical route to estimating the extremal index, capturing clustering of rare events.

Dynamical systems models should not be used in applied ecology

Mike Bode
Collaborators: Larissa Lubiana Botelho, Sarah Vollert, Cailan Jeynes-Smith
Queensland University of Technology

For a century, mathematicians have promised that dynamical systems models can translate mechanism into prediction. That promise has failed. Not only do these models not deliver reliable predictions for management, they cannot do so. When asked the central applied question: what will happen if we intervene, these models collapse into ambiguity. The problem is not that ecologists have used the wrong algorithm, fitted too little data, or failed to add enough biological realism. The problem is structural. Ecological systems are too underdetermined, too nonlinear, too diffuse, and too poorly observed for traditional dynamical models to function as predictive decision-support tools. This talk argues that predictive dynamical systems ecology is a dead end.

Stable Interaction Rule Discovery in Random Survival Forests for Censored Survival Data

Mildred Mmbone
Supervisors/Collaborators: Prof. Helen Thompson, DProf. Kerrie Mengersen
Queensland University of Technology

Random Survival Forests (RSF) provide a flexible non-parametric framework for modelling complex survival outcomes with nonlinear effects and higher-order interactions. However, despite their strong predictive performance, RSF models are often difficult to interpret, particularly when identifying reproducible subgroup structures associated with survival differences. Existing approaches primarily focus on variable importance measures or terminal node predictions, offering limited insight into stable interaction patterns across repeated model perturbations.

This study proposes a stability-based framework for interpretable subgroup discovery in censored survival data using repeated RSF perturbations and explicit rule extraction. Root-to-terminal node decision paths are reconstructed from individual survival trees to obtain clinically interpretable interaction rules. To assess reproducibility, the RSF is repeatedly refitted across multiple random seeds, and rule stability is quantified as the proportion of runs in which a rule is recovered. Stable rules are subsequently evaluated using subgroup support and fixed-horizon survival contrasts.

A simulation study based on flexible parametric survival models is used to assess whether the proposed framework can recover known comorbidity and clinical interaction structures under repeated perturbations of the data-generating process. Simulated survival outcomes are generated using realistic covariate distributions derived from a breast cancer cohort, while prespecified interaction effects are introduced into the survival mechanism. The framework is then evaluated based on its ability to recover true interaction structures while avoiding unstable or spurious subgroup patterns.

The proposed methodology is further illustrated using data from women diagnosed with late-stage invasive breast cancer in Queensland, Australia. Preliminary findings suggest that repeated perturbation combined with stability assessment can identify reproducible subgroup structures associated with substantial differences in long-term survival outcomes. The framework provides an interpretable approach for interaction discovery in survival forests and contributes to ongoing work in reproducible machine learning for censored survival data.

Using optimal control to forecast temperature overshoot outcomes

Nina Rynne
Supervisors/Collaborators: Ryan Heneghan, Melanie Roberts, Michael Bode
Griffith University

Carbon Dioxide Removal (CDR) is considered essential to achieve the Paris Agreement target, but success will depend on how quickly CDR can be scaled up and deployed. Integrated Assessment Models (IAMs) project climate outcomes by modelling future CO2 emissions reductions and removal, but contain assumptions about technological progress, and include only a subset of potential CDR methods – primarily due to the speculative nature of future CDR technology. These constraints limit analysis of how the speed and scale of CDR deployment will affect Paris Agreement outcomes, allowing only a limited range of deployment trajectories to be explored. To address this gap, we use an optimal control model to explore the duration and magnitude of temperature overshoot across a wide range of CDR deployment volumes and growth rates. We find distinct thresholds in CDR deployment required to achieve the Paris Agreement, and that fast growth rates, rather than high maximum capacity, minimise the duration and magnitude of overshoot.

Guiding Great Barrier Reef conservation with a hybrid machine learning model of an irruptive pest species

Owen Stewart
Supervisors/Collaborators: Professor Michael Bode, Dr Samuel A. Matthews, Dr David Warne
Queensland University of Technology

Irruptive species exhibit rapid and severe increases in abundance termed irruptions, that can result in significant economic and environmental damage. Forecasting these irruptions is crucial for effective prevention and management, however is difficult due to the inherent complexity of the ecosystems and the conditions that trigger irruptions. Hybrid machine learning (ML) modelling has the potential to offer more accurate predictions than standard mechanistic, statistical, and ML approaches by combining the flexibility of ML methods with existing mechanistic knowledge. In this work, we develop the first hybrid forecasting model for crown-of-thorns starfish (COTS) irruptions on the Great Barrier Reef (GBR), a species that contributes substantially to ecosystem degradation. When compared to existing COTS models, our hybrid approach produces more accurate short term forecasts that would result in significant improvements to the ability of COTS managers to identify irruptive reefs. This model also produces accurate hindcasts, and shows promise for predicting irruptions during critical periods at the initiation of GBR-scale irruptive events. Our model's hybrid components include mechanistic models of COTS larval dispersal between reefs, emphasising the influence of this process on COTS population dynamics. More generally, these results contribute to the growing body of evidence that hybrid modelling of ecological dynamics may offer improvements over more commonly used alternatives.

Connecting Vertex Based and Centroid Based Epithelial Monolayer Models

Patrick Grant
Collaborators: James Osborne, Stuart Johnston, Ryan Murphy, Matt Faria
Univerity of Melbourne

In this research, we are investigating the relationship between a two-dimensional, quadrilateral, vertex model based on the work of (Brown et al, 2025) and a one-dimensional cell centroid model. The aim being to derive a continuum limit PDE approximation for the behaviour of epithelial monolayers. The movement of the vertices in the two-dimensional model is determined by the minimisation of the cell energy where each cell wants to maintain a target area and perimeter, determined from the cell age. Several mechanisms are introduced to allow stability with realistic levels of cell proliferation. In order to calculate motion in the centroid model forces are computed by first reconstructing a two-dimensional cell structure (from the cell centroids) and the forces calculated on each reconstructed vertex using a vertex dynamics model. These forces are then acted on the cell centroids which allow the monolayer to be represented as a single chain of centroids aiding calculation of a continuum representation. We compare the behaviour of these two models and investigate the parameters that can be used to connect them.

Dual-scale modelling of two-dimensional flow in locally-periodic porous media

Patrick Hassard
Collaborators: TBC
Queensland University of Technology

The macroscopic approach for modelling incompressible flow in heterogeneous porous media typically uses the method of volume averaging as an upscaling method to overcome the difficulties associated with quantifying flow within the complex geometry of the underlying pore network. A potential difficulty of this approach is the requirement to specify permeability, an effective parameter which appears in the definition of flux when using Darcy's law.

Homogenisation theory is often used to predict such parameters as permeability from the microstructure of the porous medium. This type of uncoupled scaling approach results in an efficient simulation, but is unable to accurately represent flows that cannot produce fully uncoupled problems, such as flows with non-negligible Reynolds numbers (which we term visco-inertial). This provides motivation for moving towards a completely coupled, dual-scale modelling approach, which is much more computationally expensive, but can be applied to a wider range of flow problems.

We discuss several dual-scale models of flow in locally-periodic porous media (heterogeneous media where the underlying porous structure varies slowly). We consider both Stokes flow and visco-inertial flow, and use Boundary Element and Lattice Boltzmann methods at the pore scale, and Control Volume Finite Element at the macroscale. We are able to exploit the locally-periodic structure to develop efficient models that still capture the underlying heterogeneity.

Hydrodynamics of the Fitzroy River Estuary

Sadegh Derakhshan
Supervisors/Collaborators: Melanie Roberts
Griffith University

Hydrodynamics of the Fitzroy River Estuary

World heritage listed Great Barrier Reef is under numerous natural and anthropogenic stressors such as excessive nutrients and fine sediment. Fitzroy river basin drains into the Great Barrier Reef region and makes a significant contribution to the total sediment and nutrients transported to the GBR lagoon. Fitzroy River Estuary, the interface between the Fitzroy River and the Pacific Ocean, is a macrotidal estuary with a tidal range of around 4m the. The hydrodynamics of estuarine systems is quite complex with multiple physical mechanisms at play; with tidal oscillations and the discharge from the river, as the main mechanisms and Coriolis effect, salinity, turbidity and temperature gradients as minor ones. The hydrodynamics of estuaries dictates and precedes sediment dynamics and nutrient transport within and outside the estuaries and therefore understanding the hydrodynamics of estuaries is the key to understanding the latter phenomena. A field data collection campaign was launched in 2024 by a team from the Department of Environment Tourism Science and Innovation, measuring water level, current velocity and sediment in the Fitzroy River Estuary. The SCHISM hydrodynamic model was ran using the field data to validate the model results.

The objective of this project is therefore to explore and discuss the hydrodynamics of the Fitzroy River Estuary using field data and hydrodynamic modelling.

Optimal responses to randomness - Control in complex stochastic systems

Sakshi Jain
Collaborators: Gianmarco Del Sarto, Franco Flandoli, Stefano Galatolo and Angxiu Ni
University of Queensland

Our goal is to determine the optimal drift of a stochastic system in order to maximise the expectation of a given payoff function. We characterise optimal perturbations within a class of admissible controls and relate the problem to long-time behaviour.

Revisiting the continuum limit of a free boundary model of mechanical cell interactions

Shahak Kuba
Supervisors/Collaborators: Matthew Simpson, Pascal Buenzli
Queensland University of Technology

The rate at which biological tissues grow is regulated by the interplay between geometry, cell mechanics, and cellular processes. In scenarios where tissue growth occurs primarily at the surface of a confined environment — such as bone remodelling, wound healing, and tissue growth within engineered scaffolds — cells compete for space as they deposit new material. This competition leads to cell crowding or spreading depending on substrate curvature and generates mechanical stresses that may influence cellular processes including proliferation, differentiation, and survival. We present a discrete mathematical model for simulating tissue growth in confined geometries. The tissue interface is represented as a chain of mechanically interacting cells (modelled as springs) that simultaneously generate new tissue material. To more accurately capture cell population dynamics during tissue growth, we incorporate cell proliferation, death, and embedment as stochastic processes. To describe the collective behaviour of the cell population, we derive a continuum limit by representing each cell with m subcellular mechanical components and taking the limit as $m \to \infty$. This derivation yields a reaction–diffusion partial differential equation governing the evolution of cell density along a moving interface parameterised by arc length.

Data Fusion using Vine Copula-based Imputation

Sithara Wijekoon
Supervisors/Collaborators: A/Prof. Gentry White. Prof. Helen Thompson. Australian Bureau of Statistics (ABS) collaborator - Summer Wang.
Queensland University of Technology

Imputation-based data fusion combines datasets by imputing missing variables in one dataset using information from the other. The validity of imputation-based data fusion relies on accurately preserving both the imputed distributions and the underlying multivariate dependence structure across data sources. However, traditional imputation-based data fusion methods often struggle to preserve the dependence structure, particularly when marginal distributions differ or when complex, nonlinear multivariate dependencies exist. Inadequate preservation of these dependencies can result in biased inference in the fused data. To address this challenge, this study introduces a novel imputation-based data fusion framework that utilises conditional sampling from C-vine and D-vine copulas as the imputation mechanism. This approach flexibly models pairwise and higher-order dependencies while accommodating heterogeneous marginal distributions, thereby generating imputations that more accurately maintain the distribution of the multivariate data. The proposed method is validated through a simulation study using survey data and a real-data application that improves the negative income distribution in survey data by integrating information from administrative tax records. Results indicate that the proposed method outperforms existing approaches in preserving both the imputed distributions and the dependence structure across datasets.

Is bigger better? Analyzing the trade-off between management area and management intensity in conservation planning.

Tapash Alister
Supervisors/Collaborators: Matthew Holden
University of Queensland

In conservation planning, a nearly universal issue is deciding how much area should be managed and while it is often seen as optimal to manage as much area as possible, this may not always be the correct decision. In particular, when limited resources are available, an overly large area can dilute these resources to the point of ineffectuality. In this talk, I will explore this trade-off between the spatial extent and the per unit area intensity of management actions, introducing a general framework for tackling these problems along with approaches pertaining to fisheries management near MPAs and weed clearing.

A Globally Convergent Minorization-Maximization Algorithm for Softmax-gated Gaussian Mixture of Experts Models

Tran Nguyen Tung Doan
Supervisors/Collaborators: Trung Khang Tran, Trung Tin Nguyen, Gersende Fort, Hien Duy Nguyen, Binh T. Nguyen, Florence Forbes, Christopher C. Drovandi, Tam Le Minh, Shu-Kay Ng
Griffith University

The mixture of experts (MoE) model is a widely adopted framework in multivariate analysis, particularly for clustering and nonlinear regression tasks. The Expectation-Maximization (EM) algorithm is commonly used for maximum likelihood estimation in Gaussian mixture models due to the availability of closed-form updates in the M-step and its favourable numerical properties, such as guaranteed monotonicity. However, in the context of SoftMax-gated Gaussian mixture of experts (SGMoE) models, the standard EM algorithm lacks a closed-form update in the M-step and robust convergence guarantees. These limitations can lead to substantial computational costs and unstable solutions. In this work, we examine the viability of a Minorization-Maximization (MM) algorithm that avoids the need for approximations in the M-step, which is typically required by EM-type algorithms in this context. In particular, this MM algorithm supports coordinate-wise updates of the parameter components and generates sequences of estimates that produce monotonic increases in the log-likelihood and converge to a stationary point from any initialization. These desirable properties are lacking in previously proposed approximate EM algorithms. Through numerical experiments, we test the MM algorithm on both simulated and real data and compare it with EM-type algorithms using various M-step update strategies.

Effect of Optimistic-Pessimistic Biased Environmental Perception in Evolutionary Games

Upayan Roy
Supervisors/Collaborators: Maria Kleshnina
Queensland University of Technology

The formation of human social structures requires the prevalence of cooperative individuals who incur a personal cost for the common good. Therefore, we need to understand the factors that lead to the evolution of cooperative behaviour in society. Evolutionary Game Theory provides a powerful framework to study the evolution of cooperative behaviour using simple models of repeated social dilemma games. However, most classic models of social dilemma games consider fixed payoff environments. By generalising to action-dependent payoff environments, one can model the exploitative degradation of environmental resources. It has been shown that the added risk of payoff-environment degradation in action-dependent games can act as an additional catalyst for the evolution of cooperation. Moreover, whether players have information about their payoff environments can affect the cooperation rate. In this talk, I will discuss the effect of having optimistically or pessimistically biased information about the payoff environment. I will also discuss how we formulate a simple model for such biases, along with some preliminary results, current challenges, and future directions.

Artificial Intelligence for Sustainable Crop Management under Uncertainty

Vanessa Lopez
Supervisors/Collaborators: Dr. Nan Ye, Prof. Scott Chapman, Dr. Yayong Li and Dr. Qiaomin Chen
University of Queensland

Wheat production in many agricultural systems, including Australia, depends heavily on rainfall, making nitrogen (N) fertiliser management highly uncertain. Traditional fertiliser strategies are often based on fixed schedules or heuristic rules that do not account for variability in weather, soil conditions, or long-term system dynamics. Recent advances in reinforcement learning (RL) combined with crop simulation models have shown potential for adaptive fertiliser management; however, many existing approaches rely on black-box policies with limited interpretability and robustness.

This research proposes a reinforcement learning framework for nitrogen management using the APSIM crop simulation platform. The framework formulates nitrogen management as a partially observable sequential decision-making problem and explores both discrete and continuous RL methods. A key contribution is the development of agronomically-informed structured policies that parameterize nitrogen application timing and quantity while remaining differentiable and optimizable. Policies are trained using multi-objective reward functions balancing yield, fertiliser cost, and environmental impact. Preliminary simulation experiments demonstrate the feasibility of optimizing structured RL policies within APSIM, with future work extending the framework to multi-year simulations to capture longer-term soil and climate dynamics.

Modelling the Evolution of Mechanical Stress in Epithelial Tissues

Yuuka Foo
Supervisors/Collaborators: Assoc Prof. Pascal Buenzli, Prof. Matthew Simpson
Queensland University of Technology

Modelling mechanical stress is important for capturing the mechanobiological effects that occur during tissue growth and remodelling. The continuum mechanics framework is widely used to model stress by treating tissues as continuous media. However, its application to biological systems undergoing growth and remodelling presents several limitations, particularly in the definition of a reference configuration and in the presence of residual stresses. Therefore, we derive a stress model from a one-dimensional discrete model of mechanical cell interactions and its continuum limit, describing the evolution of stress between epithelial cells along a substrate of arbitrary shape. We also formulate a separate stress model using concepts from continuum mechanics and assess its validity through comparison with the discrete model and its continuum limit. When the reference configuration is assumed to be the steady state of cells, we find that continuum mechanics fails to accurately describe the evolution of stress in the presence of residual stresses, indicating its applicability only to systems with a stress-free reference configuration. These findings have important implications for the selection of stress models to accurately capture the transient stresses during mechanical cell interactions and further highlight the limited applicability of the continuum mechanics framework to biological systems.

Multi-domain shape calculus via level-set dilation

Zachary J Wegert
Collaborators: Prof. Martin Berggren, A/Prof Vivien Challis
Queensland University of Technology

Shape calculus is a mathematical tool by which we can analyse the change in functionals under perturbations of the domain of integration. These techniques are primarily used to compute gradient information for PDE-constrained optimisation problems in which the domain is the optimisation variable.

In this talk, I will motivate PDE-constrained optimisation problems involving multiple domains. We will then consider developing new shape calculus tools for computing gradient information in this context.

List of Participants

Name	Email	Institution
Adarshkrishnan Rajakumar	n12160199@qut.edu.au	Queensland University of Technology
Adel Mehrpooya	Adel.mehrpooya@hdr.qut.edu.au	Queensland University of Technology
Adrianne Jenner	adrianne.jenner@qut.edu.au	Queensland University of Technology
Alice Hui Yao	h.yao@uq.edu.au	University of Queensland
Amanda Salpadoru	dasuniamanda.salpadoru@hdr.qut.edu.au	Queensland University of Technology
Anuradha Dhananjanie	anuradha.dewage@hdr.qut.edu.au	Queensland University of Technology
Cecilia Gonzalez Tokman	cecilia.gt@uq.edu.au	University of Queensland
Clayton Ma	Clayton.ma@connect.qut.edu.au	Queensland University of Technology
Connor O'Reilly	connor.c.oreilly@gmail.com	Queensland University of Technology
David Harman	d.harman@griffith.edu.au	Griffith University
Dylan Wildman	dyljwild@gmail.com	Queensland University of Technology
Francisca Powell	francisca.powell@csiro.au	CSIRO
Georgia Weatherley	georgia.weatherley@hdr.qut.edu.au	Queensland University of Technology
Hao Zhou	h.zhou3@uq.net.au	University of Queensland
Holly Baldock	h.baldock@uq.edu.au	University of Queensland
Huan Zhou	huan.zhou@uq.edu.au	University of Queensland
Indu B Wadhawan	indu.wadhawan@gmail.com	Queensland University of Technology
Jack Fenwick	jack.fenwick@hdr.qut.edu.au	Queensland University of Technology
Jack Fewtrell	Jack.fewtrell@hdr.qut.edu.au	Queensland University of Technology
Jamintha Samarakoon	jamintha.mudiyanselage@hdr.qut.edu.au	Queensland University of Technology
Jiading Liu	jiadingliu1999@gmail.com	University of Queensland
Jiamin Xu	j87.xu@hdr.qut.edu.au	Queensland University of Technology
Johnathan Adams	n9460012@qut.edu.au	Queensland University of Technology
Jordan Holdorf	j.holdorf@griffith.edu.au	Griffith University
Jordan McGrath	jordan.mcgrath2@griffithuni.edu.au	Griffith University
Joseph Wilson	joseph.wilson1@uqconnect.edu.au	University of Queensland
Josh Rottenberry	j.rottenberry@hdr.qut.edu.au	Queensland University of Technology
Juan Diaz	Juan.diazmartinez@griffithuni.edu.au	Griffith University
Kain Russell	kain.russell@hdr.qut.edu.au	Queensland University of Technology
Kamran Najeebullah	kamran.najeebullah@csiro.au	CSIRO
Kate Ewen	smp.research.admin@uq.edu.au	University of Queensland
Kazutoshi Yamazaki	k.yamazaki@uq.edu.au	University of Queensland
Lauren Deegan	n11184345@qut.edu.au	Queensland University of Technology
Luz Pascal	l.pascal@uq.edu.au	University of Queensland
Mackenzie Parker	mbparker0802@gmail.com	Queensland University of Technology
Manuela Mendiolar	manuela.mendiolar@csiro.au	CSIRO
Marzieh Talebi	marzieh.talebighahfarokhi@griffithuni.edu.au	Griffith University
Mason Lacy	mason.lacy@hdr.qut.edu.au	Queensland University of Technology
Mat Simpson	matthew.simpson@qut.edu.au	Queensland University of Technology
Matt Moores	Matthew.Moores@lut.fi	Technology One
Matthew Holden	m.holden1@uq.edu.au	University of Queensland
Matthew King	matthew.king@griffith.edu.au	Griffith University
Max Auer	m.auer@uq.edu.au	University of Queensland
Meagan Carney	m.carney@uq.edu.au	University of Queensland
Melanie Roberts	m.roberts2@griffith.edu.au	Griffith University
Michael Bulmer	m.bulmer@uq.edu.au	University of Queensland
Mike Bode	michael.bode@qut.edu.au	Queensland University of Technology
Mildred Mmbone	mildredmmbone.lumwamu@hdr.qut.edu.au	Queensland University of Technology
Monique Swart	monique.swart1101@gmail.com	Queensland University of Technology
Morenikeji Deborah Akinlotan	morenikeji.akinlotan@qut.edu.au	Queensland University of Technology
Nadiah Kristensen	nadiah@nadiah.org	Queensland University of Technology
Narayan	narayanseshadri.srinivasan@hdr.qut.edu.au	Queensland University of Technology
Nathan Garland	n.garland@griffith.edu.au	Griffith University
Nick Beeton	nick.beeton@csiro.au	CSIRO
Nina Rynne	nina.rynne@griffithuni.edu.au	Griffith University
Obi Carwood	carwoodobi@gmail.com	Queensland University of Technology

List of Participants is continued on the next page.

List of Participants (Continued)

Name	Email	Institution
Oriolson Rodriguez	oriolson.rodriguezramirez@hdr.qut.edu.au	Queensland University of Technology
Owen Stewart	owen.stewart@hdr.qut.edu.au	Queensland University of Technology
Pascal Buenzli	pascal.buenzli@qut.edu.au	Queensland University of Technology
Patrick Grant	psgrant@unimelb.edu.au	Univerity of Melbourne
Patrick Hassall	p.hassall@uq.edu.au	University of Queensland
Patrick Hassard	p.hassard@qut.edu.au	Queensland University of Technology
Phan Thanh Huy	phant7@qut.edu.au	Queensland University of Technology
Renee Oldfield	renee.oldfield@uq.edu.au	University of Queensland
Riley Whebell	r2.whebell@qut.edu.au	Queensland University of Technology
Roslyn Hickson	Roslyn.Hickson@csiro.au	JCU and CSIRO
Ruoxuan Shi	ruoxuan.shi@uq.edu.au	University of Queensland
Ryan Heneghan	r.heneghan@griffith.edu.au	Griffith University
Sadegh Derakhshan	sadegh.derakhshan@griffithuni.edu.au	Griffith University
Sakshi Jain	sakshi.jain@uq.edu.au	University of Queensland
Samuel Stephen	sstephen3@usc.edu.au	University of the Sunshine Coast
Scott Wiggins	swiggins@wmac.com.au	West Moreton Anglican College
Selva Salimi	selva.salimi@hdr.qut.edu.au	Queensland University of Technology
Shahak Kuba	s.kuba@qut.edu.au	Queensland University of Technology
Sithara Wijekoon	sithara.mudiyanselage@hdr.qut.edu.au	Queensland University of Technology
Stephen Sanderson	stephen.sanderson@uq.edu.au	University of Queensland
Tapash Alister	t.alister@uq.edu.au	University of Queensland
Thanh Huy Phan	phant7@qut.edu.au	Queensland University of Technology
Thomas Steele	n11014164@qut.edu.au	Queensland University of Technology
Tran Nguyen Tung Doan	tung.doan@griffithuni.edu.au	Griffith University
Upayan Roy	upayan.roy@hdr.qut.edu.au	Queensland University of Technology
Vanessa Lopez	a.lopezcorona@uq.edu.au	University of Queensland
Vivien Challis	vivien.challis@qut.edu.au	Queensland University of Technology
Yihan Liu	y350.liu@hdr.qut.edu.au	Queensland University of Technology
Yiru Chen	y589.chen@hdr.qut.edu.au	Queensland University of Technology
Yumeng Shi	symmel2020@gmail.com	Queensland University of Technology
Yuuka Foo	n12551554@qut.edu.au	Queensland University of Technology
Zachary J Wegert	wegert@qut.edu.au	Queensland University of Technology
Zihao Wang	z308.wang@hdr.qut.edu.au	Queensland University of Technology
Zoltan Neufeld	z.neufeld@uq.edu.au	University of Queensland

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