2023 QANZIAM Conference

Griffith University, Nathan Campus

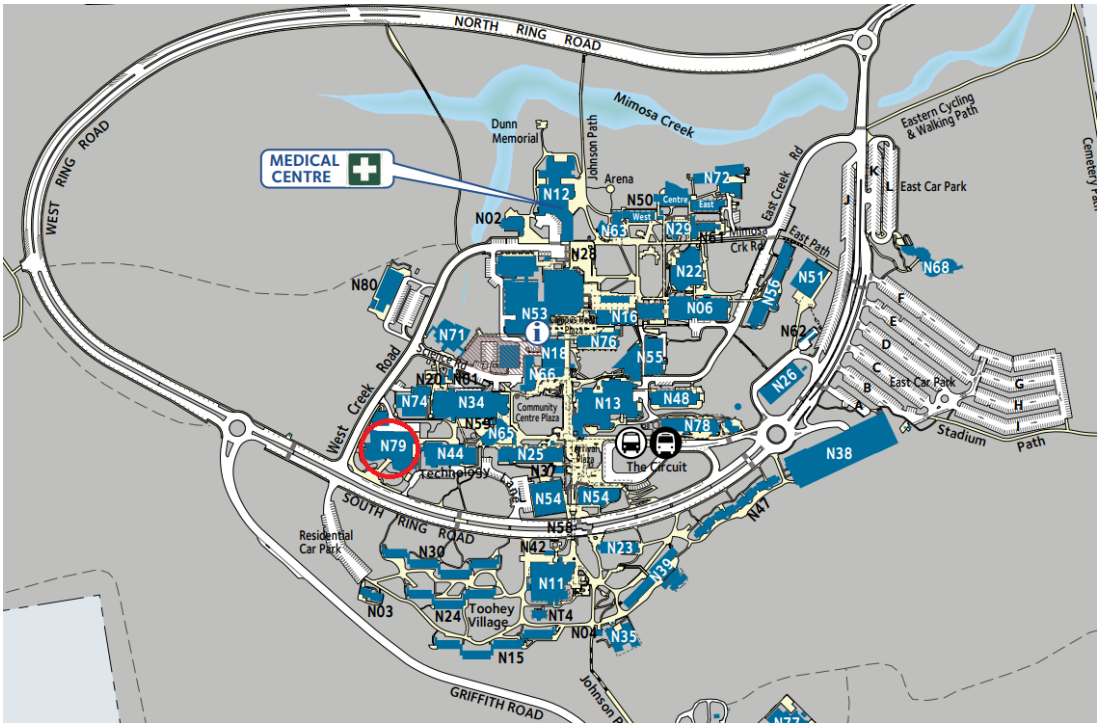
Thursday, June 29, 2023

Location

The 2023 QANZIAM Conference will be held at Griffith University, Nathan campus. The Nathan campus is located at 170 Kessels Road, Nathan, 4111.

The conference will be held in rooms N79_1.05A and N79_1.05B (Building 79, Rooms 1.05A and 1.05B). N79 is circled on the map below.

- When entering N79 from **South Ring Road**, you will enter on Level 1 and the conference rooms will be immediately on your left.
- When entering N79 using the entrance **opposite N44**, you will enter on Level 0. Take the lift or stairs (on your left after entering N79) to Level 1. After exiting the lift or stairs, follow the short hallway to Rooms 1.05A and 1.05B.



Single day parking is available on West Ring Road (to the left of the roundabout on the map above). Single day parking is also available in East Car Park (above N38 on the map above). Note that parking on Nathan campus is NOT free. See below link for information on how to pay for a single day (Pay-By-Plate machines or using the PayStay app). https://www.griffith.edu.au/transport/parking/paying-for-parking/casual-parking

Schedule: N79_1.05B

Time	Speaker	Title
08:30 – 09:00		Registration
09:00 – 09:20		Welcome
09:20 – 09:40	Jordan Holdorf (Griffith)	Investing in mangrove restoration in a changing environment within a natural capital market framework
09:40 – 10:00	Sarah Vollert (QUT)	Unlocking ensemble ecosystem modelling for large and complex networks
10:00 – 10:20	Ryu Lippmann (QUT)	Optimizing Logistics for Coral Aquaculture Deployment
10:20 – 10:40	John Lyons (UQ)	Regime shift in Antarctica
10:40 – 11:10		Morning Tea
11:10 – 11:30	Georgia Weatherley (QUT)	Agent-based modelling of the spatial dependence of myelin repair in multiple sclerosis
11:30 – 11:50	Llewyn Randall (Griffith)	Incorporating rainfall impact detachment into gully erosion models
11:50 – 12:00		Short 10 minute break (no catering)
12:00 – 12:50	**Invited Speaker** Vivien Challis	Computational structural optimisation of piezoelectric materials
12:50 – 13:50		Lunch
13:50 – 14:40	**Invited Speaker** Jerzy Filar	The Story Behind Hidden Equations of Threshold Risk
14:40 – 14:50		Short 10 minute break (no catering)
14:50 – 15:10	Zachary J Wegert (QUT)	Multi-phase level set topology optimisation methodologies: Comparison and outlook
15:10 – 15:30	Jonathan Wilton (UQ)	Positive-Unlabelled Learning using Random Forests via Recursive Greedy Risk Minimisation
15:30 – 16:00		Afternoon Tea
16:00 – 16:20	Patrick Grant (QUT)	Constructing Virtual Representations of Laminated Timber Products
16:20 – 16:40	Michael Bode (QUT)	Guiding crown of thorns starfish control efforts on the Great Barrier Reef
16:40 – 16:50		Special Election - QANZIAM Treasurer
16:50 – 17:00		Close of Conference

Schedule: N79_1.05A

When a time slot has no speaker/title, please join N79_1.05B for combined session.

Time	Speaker	Title
08:30 – 09:00		
09:00 – 09:20		
09:20 – 09:40	Joshua Peters (UQ)	Prevalence of stability for smooth Blaschke product cocycles fixing the origin
09:40 – 10:00	Zhihao Qiao (UQ)	An EM Framework for Competing Risks via Multi-Absorbing Phase Type Distributions
10:00 – 10:20	Steven Kedda (QUT)	Self-similarity and Fractalisation in Interfacial Hydrodynamics
10:20 – 10:40	Ryan Kelly (QUT)	A misspecification-robust Bayesian inference method for scientific simulators
10:40 – 11:10		Morning Tea
11:10 – 11:30	Matthew King (Griffith)	Non-chaotic fluctuations within a modified Ehrenfest wind-tree model
11:30 – 11:50	Alistair Falconer (UQ)	A flexible agent-based model for epithelial cell migration
11:50 – 12:00		Short 10 minute break (no catering)
12:00 – 12:50		
12:50 – 13:50		Lunch
13:50 – 14:40		
14:40 – 14:50		Short 10 minute break (no catering)
14:50 – 15:10	Rory Marriott (Griffith)	Predicting drug release rates from polymeric medical devices using compartmental models
15:10 – 15:30	Faris Alsubaie (UQ)	Modelling of Tissue Invasion in Epithelial Monolayers
15:30 – 16:00		Afternoon Tea
16:00 – 16:20	Luke Filippini (QUT)	Surrogate models for diffusion-controlled release from radially-symmetric geometries
16:20 – 16:40		
16:40 – 16:50		
16:50 – 17:00		

Invited Speakers

Computational structural optimisation of piezoelectric materials

Vivien Challis

Collaborators: Zach Wegert and Tony Roberts

Queensland University of Technology

Structural optimisation is a powerful computational approach for designing structures or microstructures for particular physical properties. The approach combines numerical solution of the relevant state equations with a density- or level set-based description of the structure that facilitates optimisation of the design objective. I'll introduce structural optimisation and outline the common approaches. I'll then introduce the phenomenon of piezoelectricity and present recent work optimising new periodic microstructures for both stiffness and piezoelectric response. Such microstructures are manufacturable by exploiting modern 3D printing technologies and I'll talk about potential applications as next-generation robotic stress sensors.

The Story Behind Hidden Equations of Threshold Risk

Jerzy A. Filar

Collaborators: Vladimir Ejov and Zhihao Qiao

University of Queensland

One simple notion of risk is simply the probability of some random variable falling below (or above) some designated threshold. This is what motivates the "threshold risk problem".

On some level the problem is at least as old as the history of agriculture with farmers being concerned about rainfall falling below some acceptable level, or onset of frost; a prototypical tipping point for successful cultivation of certain crops. More recently, concerns about climate change induced global warming focused on the level of such warming exceeding thresholds such as 1.5 or 2.0 degrees C, by the year 2030 or 2050.

Because of the ubiquity of applications, it would be reasonable to assume that mathematical properties of threshold risk have been fully understood long ago. Yet, we encountered two separate applications – one in hospital admissions and another in fishery modelling - where threshold risk exhibited a characteristic extreme parametric sensitivity phenomenon which we could not easily explain.

This led to a deeper, and a more mathematically abstract, investigation of this phenomenon. Specifically, we considered the problem of parametric sensitivity of risk, with respect to a threshold parameter δ. Such threshold risk was modelled as the probability of a δ-perturbed function of a random variable falling below 0. We demonstrated that for polynomial and rational functions of that random variable there exist at most finitely many risk critical points. The latter are those special values of the threshold parameter for which rate of change of risk is unbounded as δ approaches them. Under weak conditions, we characterised candidates for risk critical points as zeroes of either the discriminant of a relevant δ-perturbed polynomial, or of its leading coefficient, or both. We named these important equations as "hidden equations of risk critical thresholds", because some knowledge of algebra and analysis is required to discover them. We also supplied extensions to multi-parameter threshold risk.

The talk will also contain some advice for higher degree students in mathematical sciences.

Talk Abstracts

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

A flexible agent-based model for epithelial cell migration

Alistair Falconer

Supervisor: Dietmar Oelz

University of Queensland

Collective cell migration is an essential biological process in the formation and maintenance of tissues, yet the regulation of this migration is still little understood. We formulate a 2D particle model for the collective cell migration in a confluent monolayer of epithelial cells within both open and constrained geometries. Key elements of the model are a mutual reinforcement between cell polarity and velocity, as well as a process to determine neighbourhoods of cells through adjacency in the associated Voronoi tessellation. We apply this model to describe certain experimental results concerning the onset of large-scale global migratory behaviour.

Agent-based modelling of the spatial dependence of myelin repair in multiple sclerosis

Georgia Weatherley

Supervisors: Adrianne Jenner, Robyn Araujo

Multiple Sclerosis (MS) is a disease that is autoimmune, neurological, and rising in prevalence. Sustained immune dysfunction drives the damage of the protective myelin sheaths of axons, resulting in neurodegeneration and the formation of lesions. MS patients experience a range of symptoms that are diverse and often debilitating, with medical interventions currently concerned with symptom management given the absence of a cure. Recognising the heterogeneity and complex eitology of MS, we identify an opportunity for mathematical insight and develop an agent-based model of the immune-driven degradation and repair of myelin. We capture the spatial dependence of myelin repair in a local neighbourhood through cellular automaton conditions, finding that our assumptions around the local resilience of repair mechanisms in MS have a significant impact on lesion outcomes. Furthermore, we investigate implicit treatment effects, suggesting that positive, long term lesion outcomes may be primarily contingent on the resilience of a patient's repair system in the face of ongoing immune inflammation.

Modelling of Tissue Invasion in Epithelial Monolayers

Faris Alsubaie

Supervisor: Zoltan Neufeld

Mathematical and computational models are used to describe biomechanical processes in multicellular systems. Here, we develop a model to analyse how two types of epithelial cell layers interact during tissue invasion depending on their cellular properties, i.e., simulating cancer cells expanding into a region of normal cells. We model the tissue invasion process using the Cellular Potts Model and implement our two-dimensional computational simulations in the software package CompuCell3D. The model predicts that differences in mechanical properties of cells can lead to tissue invasion, even if the

division rates and death rates of the two cell types are the same. We also show how the invasion speed varies depending on the cell division and death rates and the mechanical properties of the cells.

Positive-Unlabelled Learning using Random Forests via Recursive Greedy Risk Minimisation

Jonathan Wilton

Supervisors: Abigail M. Y. Koay, Ryan K. L. Ko, Miao Xu, Nan Ye

University of Queensland

The need to learn from positive and unlabelled data, or PU learning, arises in many applications and has attracted increasing interest. While random forests are known to perform well on many tasks with positive and negative data, recent PU algorithms are generally based on deep neural networks, and the potential of tree-based PU learning is under-explored. In this paper, we propose new random forest algorithms for PU-learning. Key to our approach is a new interpretation of decision tree algorithms for positive and negative data as recursive greedy risk minimization algorithms. We extend this perspective to the PU setting to develop new decision tree learning algorithms that directly minimizes PU-data based estimators for the expected risk. This allows us to develop an efficient PU random forest algorithm, PU extra trees. Our approach features three desirable properties: it is robust to the choice of the loss function in the sense that various loss functions lead to the same decision trees; it requires little hyperparameter tuning as compared to neural network based PU learning; it supports a feature importance that directly measures a feature's contribution to risk minimization. Our algorithms demonstrate strong performance on several datasets.

Investing in mangrove restoration in a changing environment within a natural capital market framework

Jordan Holdorf

Supervisors: Chris Brown, Melanie Roberts, Ivan Diaz-Rainey

Griffith University

Interest in natural capital markets is steadily growing with strong interest in the emerging carbon and biodiversity markets. This promotes the need to make investment decisions in a financial framework, which allows restoration projects to benefit from these emerging markets. Currently, most funding for restoration comes from philanthropic and/or grants, which means that traditional methods such as Marxan aim to minimise the cost of the project rather than focusing on the financial markets the project can produce revenue. This leads to the demand for a financial framework that focuses on restoration projects utilising these emerging markets and maximising the overall revenue of the project. We must also consider climate change as it is a major risk to ecological investments. Therefore, not only do models need to include emerging natural capital markets, but also need to account for climatic uncertainty, so informed decisions are able to be made.

Regime shift in Antarctica

John Lyons

Queensland University of Technology

The focus of this research is to identify, classify and investigate Antarctic ecosystems that show evidence of a regime shift. Using this information, it aims to provide insights into the overall health of Antarctica's ecosystems. Here we look at colonies of Adelie Penguins that have collapsed, and investigate why. And what tools we have to detect other regime shifts.

Prevalence of stability for smooth Blaschke product cocycles fixing the origin

Joshua Peters

Supervisor: Cecilia Gonzalez-Tokman

University of Queensland

Formulating dynamical systems that model real world phenomena is an enormous, arguably impossible challenge facing applied mathematicians. Due to the number of uncontrollable degrees of freedom, one may question whether small modelling errors influence the long term predictions for such systems in a comparably small or drastic fashion. In recent years, significant progress has been made in exploring the robustness of autonomous and non-autonomous systems under perturbations, in both finite and infinite dimensional settings, but many problems remain entirely open. In this work, we address this question using the theory of prevalence and investigate the stability properties of Lyapunov exponents of transfer operator cocycles from a measure-theoretic perspective. Our results focus on so-called Blaschke product cocycles, a class of random dynamical systems amenable to rigorous analysis. We show that amongst smooth monic quadratic Blaschke product cocycles fixing the origin, those which are stable form a prevalent set. Further, through a perturbative method we show that almost every smooth Blaschke product cocycle fixing the origin is stable.

Mathematical modelling of ongoing disturbances on the Great Barrier Reef

Kaitlyn Brown

Supervisors: Adrianne Jenner, Robyn Araujo, Paul Corry

Queensland University of Technology

Ecological models are a crucial component of the effective conservation management of coral reef ecosystems under increasing environmental perturbation. However, parameterizing models over decadal timescales often leads to significant uncertainty and limited predictive capability. Here, we propose a novel deterministic modelling framework to capture on-going disturbances of coral reef dynamics. Initial calibrations to empirical data highlighted practical identifiability issues under the assumption of static parameterisations. To overcome this, we introduce temporal variance to the model parameterisation by discretely segmenting observations with respect to historical records of environmental disturbances. We estimate parameter distributions for a selection of reefs across the Great Barrier Reef using sparse observations recorded across several decades. Our initial results indicate that this framework adeptly captures the qualitative changes in reef dynamics over extended periods of time in the presence of ongoing disturbances.

Incorporating rainfall impact detachment into gully erosion models

Llewyn Randall

Supervisor: Melanie Roberts

Griffith University

Alluvial gully erosion contributes a significant amount of sediment to marine and freshwater ecosystems in Queensland and is linked with declines in ecosystem health. As a result, MERGE was constructed to apply a process-based approach to modelling erosion in gullies of simplified geometry under constant flow. The deposition layer in MERGE is constructed of sediment which has broken the cohesion of the original soil matrix, become detached and is readily entrained into the water column. Despite being able to accommodate a layer of deposited sediment as an initial input, MERGE simulations often neglect it due to the poorly understood dynamics. Rainfall impact has been identified as a large contributor to this initial layer, so RIDGE has been created to directly couple with MERGE to assess the change in simulation results.

Through observing previous approaches to modelling rainfall impact detachment, RIDGE has been developed with a particular focus on limiting the input requirement of experimental data. A commonly used approach of equating the energy available in a rainfall event with the energy required to detach sediment is taken. Additional inputs of a building flow depth better couples it to MERGE and allows for the attenuation of rainfall power to be incorporated. In particular, RIDGE uniquely models raindrop impact as a compressive force, accounting for soil cohesion as a factor to differentiate between soil types.

RIDGE demonstrates behaviour consistent with expected outputs but lacks the comparison with field data to truly verify results. The model has room for refinement and supporting experimental results will help to evaluate the energy transference constant. RIDGE is particularly sensitive to raindrop velocity so incorporating variable raindrop size distribution will be an important step in development. Likewise, redetachment and soil shielding dynamics are not included which are likely to be important to describe the approach to a maximum deposition layer depth limit. There is also the capacity to define changes to soil characteristics as saturation ensues, specifically cohesion, friction and density.

When rainfall impact detachment is included for soft soils, MERGE experiences a first flush effect where the layer present in the gully head is rapidly entrained into the water column in a pulse of high concentration which is sustained for the duration of the simulation. In this re-entrainment regimen, the deposition layer continues to grow under flow, just downstream of the high-powered head, with sediment scoured from the walls being deposited out of the highly concentrated water column. In contrast, the medium and firm soils quickly entrained the deposition layer throughout the entire gully and sustain an almost non-existent layer throughout the simulation. There was minimal difference between simulations under low- versus high-intensity rainfall scenarios.

Due to changes to concentration dynamics being mostly limited to the first 20 minutes, with trends becoming almost indistinguishable both with and without initial deposition, the delivery output does not change by extending simulations. This means that including rainfall impact detachment presents an otherwise unaccounted-for sediment load being delivered to the receiving environment. The concentration dynamics are highly dependent on the change in flow depth with time so, steps should be taken to improve the modelling of the flow depth transition between RIDGE and MERGE.

It is evident that including RIDGE alongside MERGE is most applicable where rainfall events are frequent but remain in a state of flow for just long enough for the deposited layer to be flushed from the gully. It is also worth investigating the effect that rainfall impact detachment may have on gullies for which MERGE is less suited, such as large amphitheatres, as well as the involvement that rainfall impact detachment has on destabilising sediment and driving gravity-driven collapse.

Surrogate models for diffusion-controlled release from radially-symmetric geometries

Luke Filippini

Supervisors: Elliot Carr and Matthew Simpson

Queensland University of Technology

Surrogate models are frequently used in numerous disciplines to approximate more complex models of diffusion-controlled heat or mass transport. These models are appealing because they can be relatively simple, ease the process of fitting experimental release data, and highlight the influence of key physical parameters on the release profile. Recently, a moment-matching approach was proposed and used to develop a simple one-term exponential model for diffusion-controlled particle release from homogeneous radially-symmetric geometries. In this talk, I discuss the development of novel two-term and weighted two-term exponential models, using this moment-matching approach, to improve upon this existing research. Important applications of this work include drug delivery from cylindrical and spherical microcapsules and the drying of thin agricultural products.

Non-chaotic fluctuations within a modified Ehrenfest wind-tree model

Matthew King

Supervisor: Owen Jepps

The fluctuation relation first described by Evans, Cohen, and Morris in 1993 is one of the few identities in statistical mechanics which holds arbitrarily far from equilibrium. There are currently two competing theoretical treatments for the fluctuation relation, the Gallavotti-Cohen Fluctuation Theorem requires the dynamics of the system be chaotic, and the Evans-Searles Fluctuation Theorem requires the dynamics of the system display T-Mixing (or a decay in correlations over time). While the two conditions of chaoticity and T-mixing are often closely intertwined, they lead to differing conditions under which the fluctuation relation will hold. Here, we present results from the study of a modified Ehrenfest wind-tree model which appears to display fluctuations consistent with the fluctuation relation in the absence of chaotic dynamics but in the presence of a decay in auto-correlation, suggesting that T-mixing may be a more consistent candidate for the necessary conditions for the fluctuation relation to hold.

Guiding crown of thorns starfish control efforts on the Great Barrier Reef

Michael Bode

Collaborators: Cameron Fletcher, Severine Choukroun, Owen Stewart, Luciano Mason

The crown of thorns starfish (COTS) is a venomous invertebrate predator whose periodic outbreaks are a major contributor to coral decline on Australia's GBR. Millions of dollars are spent each year physically removing COTS adults from outbreak reefs, in an attempt to stop the damage. The dispersal of COTS larvae on ocean currents plays a critical role in these outbreaks, depositing billions of juvenile larvae on reefs downstream of outbreaks. We use models that combine numerical hydrodynamic models and agent-based particle tracking models to predict where these larvae will go. I will outline a recent collaboration between researchers and reef managers to create and incorporate multi-model ensemble predictions of larval dispersal into decision-making systems. Uncertain larval dispersal predictions are fed into a multi-criteria optimisation process, which considers the multiple values offered by different reefs in the GBR World Heritage Area, including biological, economic, and cultural values.

Constructing Virtual Representations of Laminated Timber Products

Patrick Grant

Supervisors: Ian Turner, Steven Psaltis, Maryam Shirmohammadi

Queensland University of Technology

The complex structure of timber has traditionally been difficult to model as it is a highly heterogeneous material. In timber species used in the construction of laminated timber products, such as Pinus radiata (radiata pine), the density can vary by up to a factor of four times within the span of a few millimetres over the growth rings. Numerical simulation methods are becoming more prevalent as a method of predicting moisture migration, stress and strain distributions, and fungal/rot intrusion in timber. These methods require a virtual description of an individual board that captures the heterogeneities present within structural timbers. In this work, a low-cost algorithm based on image analysis techniques and spectral segmentation is developed for generating a virtual model of a laminated timber panel. The virtual model is constructed by defining each individual component using a three-dimensional mesh structure, with specific wood material properties allocated to each mesh element. The initial step involves identifying the growth ring structure of a single board by analysing a photograph or image of the end grain, achieved by applying thresholding and image smoothing techniques. This process generates a mask that accentuates the darker, latewood portions of the board, resulting in a binary image that clearly displays the locations of the growth rings. The growth rings are then identified using a spectral clustering algorithm, which performs exceptionally well on the test images of radiata pine (quartersawn, plainsawn and back sawn boards). Next, the centre of the tree (pith) is located by using an iterative constrained least-squares algorithm. We assume the growth rings to be circular arcs and compute a least-squares fit for each growth ring, fitting for the centre and the radius, by refining the centre location and radius at each iteration. The density can be determined by first computing the intra-growth ring fractional radial position and passing this into a fitted five-point logistic (5PL) function. The 5PL allows for the density to be determined as a proportional length through the growth ring. The coefficients are computed from conducting image analysis on an anatomical image of the cellular structure spanning over a growth ring. Lastly, a density can be assigned for each mesh element resulting in the virtual reconstruction of a singular board. Meshes of multiple timber boards can then be combined to produce the final mesh of a laminated timber product.

Predicting drug release rates from polymeric medical devices using compartmental models

Rory Marriott

Supervisors: Owen Jepps, Yuri Anissimov, Tim Gould

Collaborators: Tatiana Spiridonova, Sergei Tverbokhlebov

Griffith University

Polymeric medical devices can be used to control the delivery rate of drugs, decreasing their toxicity and increasing patient compliance. Traditional diffusion equation-based models of drug delivery can be inaccessible to a wide range of clinical professionals and experimentalists, who may not have extensive mathematical education. Our group has developed a compartmental model that is analogous to well-known pharmacokinetic compartmental models that are widely used by pharmacists, making it more enticing for end-users. We have developed the model to incorporate diffusional transport of the solute, chemical degradation of the polymer, solute partitioning, and unstirred layer effects. Solutions to our model converge to diffusion equation solutions, as the number of compartments increases, and fits experimental data as well as the diffusion equation with a small number of compartments. We have shown that chemical degradation of the polymer can account for biphasic release profiles often

observed experimentally. It has previously been observed that drug release from polymeric particles is slower than predicted by the diffusion equation when device geometry is small. We used our model to show that this is well explained by partitioning into a hydrophilic coating. We are currently working to quantify the discrepancy between in vitro and in vivo data, by incorporating absorption into tissue to the model.

A misspecification-robust Bayesian inference method for scientific simulators

Ryan Kelly

Supervisors: Chris Drovandi, David Warne

Queensland University of Technology

Simulation-based inference techniques enable parameter estimation of mechanistic and simulable models with intractable likelihoods. Statistical approaches often suffer from inefficiencies due to wasted model simulations. Neural approaches, such as sequential neural likelihood (SNL) avoid this wastage by utilising all model simulations to train a neural surrogate for the likelihood function. However, the performance of SNL under model misspecification is unreliable and can result in overconfident posteriors centred around an inaccurate parameter estimate. We propose a novel SNL method that is robust to model misspecification and capable of identifying features of the data that the model is not able to recover. We demonstrate the efficacy of our approach on an epidemiological model to give accurate uncertainty quantification.

Optimizing Logistics for Coral Aquaculture Deployment

Ryu Lippmann

Supervisors: Paul Corry, Kate Helmstedt, Mark Gibbs

The success of large-scale projects is governed by effective planning. We optimise coral aquaculture logistics by formulating a mathematical model to determine the number, location and sizing of growth facilities, impacted by resource survival rate as a function of its growth time. We solve this problem using a two-stage algorithm and a linear mixed-integer solver. These results inform the value of data certainty to optimize the logistics of coral aquaculture production. Optimizing routing for delivering these grown corals is critical. We introduce mobile facilities to carry inventory (coral), acting in tandem with smaller vessels. We model motherships and drones based on existing extending existing formulations of trucks and drones.

Lattice Boltzmann simulations of oscillatory flow in periodic micropore structures

Samuel Stephen

Supervisors: Peter Johnston and Barbara Johnston

Griffith University

In this talk, we verify a novel axisymmetric lattice Boltzmann implementation using numerical criteria. Firstly, Hagen–Poiseuille and Womersley flow are considered within a straight tube where

analytic solutions are available. Here we establish sufficient accuracy of the approximated flow and study the effects of changing simulation parameters (e.g. Reynolds number, Womersley number) and spatial/temporal parameters (e.g. relaxation time, mesh nodes, time steps). Then, steady and oscillatory flows within a periodic, longitudinally asymmetric geometry are considered and we compare to published results where possible. Guaranteeing reasonable flow field determination for this shape is relevant to a larger problem where particulate suspension is pumped back and forth through a membrane of axisymmetric micropores - sometimes producing particle transport when there is no net flow of the carrier fluid.

Unlocking ensemble ecosystem modelling for large and complex networks

Sarah Vollert

Supervisors: Christopher Drovandi and Matthew Adams

Queensland University of Technology

Ensemble ecosystem models are valuable decision-making tools for understanding the effects of conservation actions and human impacts on threatened species. Models parameterised with system-wide constraints – such as stable coexistence – help us understand ecosystems with limited data availability. However, existing ensemble ecosystem methods become computationally inefficient as the size of the ecosystem network increases, preventing larger networks from being studied. Using Bayesian approaches, we build on current methods to overcome this technical obstacle. Here we present and demonstrate a novel sequential Monte Carlo sampling approach that yields equivalent parameter inferences and model predictions but is orders of magnitude faster than existing methods. In one of our case studies, we demonstrate that our new method speeds up the ensemble-generating process from 46 days to 41 minutes. Now, for the first time, larger and more realistic networks can be practically simulated.

Self-similarity and Fractalisation in Interfacial Hydrodynamics

Steven Kedda

Supervisors: Michael Dallaston and Scott McCue

Queensland University of Technology

Thin film equations are classes of nonlinear partial differential equations, which are applied in industrial and scientific modelling to describe the dynamics of viscous liquid flow on solid surfaces. Our work investigates the self-similar dewetting behaviour of thin film models, particularly for the case of Marangoni-driven rupture, where iterated patterns form and create an intriguing hierarchical structure. This phenomenon leads us to search for an unstable periodic orbit in a rescaled similarity space. This talk will discuss a series of challenges in modelling the interplay of these highly nonlinear effects and include numerical results of thin film evolution in the original coordinate system and rescaled similarity space. An extension of considering non-Newtonian thin film flow will be explored, with some preliminary numerical results of thin film evolution for different values of the non-Newtonian parameter.

Multi-phase level set topology optimisation methodologies: Comparison and outlook

Zachary J Wegert

Supervisors: Vivien Challis and Tony Roberts

Queensland University of Technology

Topology optimisation seeks to find a shape that optimises a design objective. The objective depends on both the geometry of the design and solution to underlying partial differential equations. In this talk, we will briefly introduce conventional level set-based topology optimisation and discuss two existing methods for optimisation of multi-phase periodic microstructures. We will consider several example optimisation problems and compare the results from these two methods. We will conclude by discussing some future work for this project.

An EM Framework for Competing Risks via Multi-Absorbing Phase Type Distributions

Zhihao Qiao

Supervisors: Budhi Surya, Azam Asanjarani, Benoit Liquet and Yoni Nazarathy

Phase-Type (PH) distributions are versatile semi-parametric models for life-time duration and can be used in survival analysis and reliability analysis. In this paper we put forward methods and software for using PH distributions in the competing risk models with mutliple absorbing states. In this case, the distribution records both the time until abosorption and the cause for absorption and is thus a bi-variate random variable with a continuous non-negative component and a discrete component. After formulating basic properties of such PH variants, which we call multi-absorbing phase type ($\text{MAPH}_{m,n}$), we adapt the EM-algorithm for parameter inference, and illustrate applications and numerical properties.

List of Participants

Name	Email	Institution
Abbish Kamalakkannan	abbish.kamalakkannan@mq.edu.au	Macquarie
Adel Mehrpooya	adel.mehrpooya@hdr.qut.edu.au	QUT
Alistair Falconer	alistair.falconer@uqconnect.edu.au	UQ
Bree Martin	bree.martin@uq.edu.au	UQ
David Harman	d.harman@griffith.edu.au	Griffith
Georgia Weatherley	georgia.weatherley@connect.qut.edu.au	QUT
Faris Alsubaie	faris.alsubaie@uq.net.au	UQ
Grace Robinson	g22.robinson@qut.edu.au	QUT
Jerzy Filar	j.filar@uq.edu.au	UQ
Jonathan Wilton	jonathan.wilton@uq.edu.au	UQ
Jordan Holdorf	jordan.holdorf@griffithuni.edu.au	Griffith
John Lyons	j8.lyons@hrd.qut.edu.au	QUT
Joshua Peters	joshua.peters@uq.net.au	UQ
Kaitlyn Brown	kaitlyn.brown@hdr.qut.edu.au	QUT
Kazutoshi Yamazaki	k.yamazaki@uq.edu.au	UQ
Llewyn Randall	llewyn.randall@griffithuni.edu.au	Griffith
Luke Filippini	luke.filippini@hdr.qut.edu.au	QUT
Manuela Mendiolar	m.mendiolar@uq.edu.au	UQ
Matthew King	matthew.king@griffith.edu.au	Griffith
Melanie Roberts	m.roberts2@griffith.edu.au	Griffith
Michael Bode	michael.bode@qut.edu.au	QUT
Owen Jepps	o.jepps@griffith.edu.au	Griffith
Patrick Grant	p21.grant@qut.edu.au	QUT
Renee Oldfield	renee.oldfield@uq.edu.au	UQ
Riley Whebell	Riley.whebell@hdr.qut.edu.au	QUT
Rory Marriott	rory.marriott@griffithuni.edu.au	Griffith
Ryan Kelly	ryan@kiiii.com	QUT
Ryan Murphy	r23.murphy@qut.edu.au	QUT
Ryu Lippmann	ryu.lippmann@hdr.qut.edu.au	QUT
Samuel Stephen	samuel.stephen@griffithuni.edu.au	Griffith
Sarah Vollert	sarah.vollert@hdr.qut.edu.au	QUT
Sarika Karanth	sarika.karanth@hdr.qut.edu.au	QUT
Scott Wiggins	swig9975@bigpond.net.au	UniSQ
Steven Kedda	nixon6887@gmail.com	QUT
Tace Stewart	tacec.97@gmail.com	QUT
Vivien Challis	vivien.challis@qut.edu.au	QUT
Zachary J Wegert	zach.wegert@hdr.qut.edu.au	QUT
Zhihao Qiao	zhihao.qiao@uq.edu.au	UQ

Code of Conduct

QANZIAM is dedicated to providing a harassment-free conference experience for everyone, regardless of gender, gender identity and expression, age, sexual orientation, disability, physical appearance, body size, race, ethnicity, religion (or lack thereof), or technology choices. Conference participants are to abide by the ANZIAM Conference Code of Conduct, which is as follows:

Harassment in any form will not be tolerated. This includes, but is not limited to, speech or behaviour (whether in person, in presentations, or in online discussions) that intimidates, creates discomfort, prevents or interferes with a person's participation or opportunity for participation in ANZIAM's vision and mission. We aim for ANZIAM to be an organisation where harassment in any form does not happen, including but not limited to harassment based on race, gender, religion, age, colour, national or ethnic origin, ancestry, disability, parental status, caring responsibilities, marital status, sexual orientation, or gender identity. Harassment includes but is not limited to verbal comments that reinforce social structures of domination; sexual images in public spaces; deliberate intimidation, stalking, or following; unwelcome photography or recording; sustained disruption of talks or other events; inappropriate physical contact; unwelcome sexual attention; and advocating for or encouraging any of the above behaviour.

All participants have a responsibility to speak out against breaches of this code of conduct. Depending on the situation, this could mean raising it with the transgressor, or reporting the behaviour to a conference organiser. If a QANZIAM member engages in harassing behaviour, the Executive Committee may take any action they deem appropriate, including warning the offender or expulsion from the Society.

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