65$^{\text{th}}$ Annual Conference of the Australian Mathematical Society

7-10 December 2021
University of Newcastle

Conference webpage: https://carma.edu.au/meetings/austms2021
Register! system: https://www.mathematics.org.au/
Zoom Events: https://events.zoom.us/e/view/erLzglwBSJ6SRQw76GBZeg
gather.town: https://gather.town/events/pc03SWuiVfic1XEV0QDz

Contents

Conference Timetable Summary

	Monday	Tuesday	Wednesday	Thursday	Friday
8:00			Special Sessions	Special Sessions	Special Sessions
8:30					
9:00		Opening Ceremony			Plenary talk *Joaquim Serra*
9:30	Early Career Workshop		Plenary talk *Emily Riehl*	Plenary talk *Susan Scott*	
10:00					Special Sessions
10:30					
11:00			EDI Panel Discussion	Plenary talk *Jennifer Flegg*	Plenary talk *Robyn Araujo*
11:30		Plenary talk *Gang Tian*			
12:00					
12:30					
13:00			Borwein Lecture *Richard Brent*	Special Sessions	Special Sessions
13:30		Panel: The State of Maths at Aust Unis			
14:00			Education Afternoon / Special Sessions		
14:30		Special Sessions			
15:00					
15:30					
16:00		Special Sessions	Special Sessions	AustMS annual general meeting	Special Sessions
16:30	WIMSIG Business Meeting (Zoom)				
17:00			Plenary talk *Chris Matthews*		
17:30					
18:00	WIMSIG Forum (Zoom)	Plenary talk *Zeev Rudnick*	Special Sessions		Closing Ceremony
18:30				Conference Dinner Customs House	
19:00	Meet & Greet: gather.town	Special Sessions			
19:30	WIMSIG Dinner Noah's				
20:00					

Foreword

Welcome to Newcastle! I hereby acknowledge the traditional custodians of the lands on which the University of Newcastle is built: the Awabakal, Darkinjung, Biripai, Worimi, Wonnarua, and Eora Nations. I pay my respect to the wisdom of the Elders past, present and future.

Another tumultuous year is coming to an end. The Australian mathematical community has suffered devastating job losses, closure of courses and degree programs, a nonsensical "no preprint rule", as well as the deprivations of the pandemic and lockdowns.

Now is a time to stand together and help each other, while remembering that the reasons we became mathematicians remain as valid as ever: Mathematics is fascinating, beautiful and important. The value of teaching Mathematics to the next generation, not only of mathematicians, but engineers, scientists, teachers and the public at large, remains undiminished.

After nearly two years of online-only conferences and the resultant Zoom fatigue, I am very pleased to welcome you to Newcastle, some online and some in person, for the 65$^{\text{th}}$ annual conference of the Australian Mathematical Society.

Hopefully next year we will all return to a fully in-person AustMS conference. In the meantime, I hope that you will meet new colleagues and reconnect with old ones, be it in person over coffee, or online in gather.town; that you will encounter new ideas; enjoy excellent talks and insightful panel discussions, and celebrate the achievements and advancements of our discipline.

Have a great conference!

Florian Breuer
Conference Director

Conference Organisation

Program Committee

Amie Albrecht (UNISA)
Maria Athanassenas (DSTO)
Vladimir Bazhanov (ANU)
Florian Breuer (UoN)
Serena Dipierro (UWA)
Vlad Ejov (Flinders U)
Jerzy Filar (UQ)
Joanne Hall (RMIT)
Anthony Licata (ANU)
Alina Ostafe (UNSW)
Gerd Schmalz (UNE)
Natalie Thamwattana (UoN)
Chris Tisdell (UNSW)
George Willis (UoN)

Local Organising Committee

Florian Breuer – Conference Director
Juliane Turner – Secretary & Treasurer
Bishnu Lamichhane, James McCoy – Special Sessions
Mat Langford – ECR Workshop Liaison
Natalie Thamwattana – WIMSIG Meeting Organiser
Stephan Tornier, Ljiljana Brankovic – Social Program
John Banks – *Register!* System
Judy-anne Osborn – Education Afternoon
Björn Rüffer – Discord Server
David Allingham – Website & Zoom
George Willis – Panel Discussion Organiser
JV Pinto e Silva, Fran Baker – Members at large
Jacob Cameron, Lucy Dowdell, Catherine Mackay, Josiah Murray, Cameron Shaw-Carmody, Chloe Wilkins – Student Volunteers

Conference Format and links

Due to the ongoing pandemic, this year's conference will follow a hybrid format.
All talks will be broadcast via Zoom Events. In parallel, there will be a face-to-face component in the NuSpace Building on the City Campus of the University of Newcastle.

Zoom Events

Please note that Zoom Events works a little differently to the usual Zoom meetings we are all used to. Instead of direct links to the various talks, every participant has received an email containing their Zoom Events ticket. With this ticket, you can sign up for the event (you'll need a zoom account, or you can sign up for one for free). Once signed up, the following link should allow you to access the Lobby: `https://events.zoom.us/e/view/erLzglwBSJ6SRQw76GBZeg`
From the Lobby, you can preview or join sessions, browse or search for them, select favourites and add them to your itinerary.
Please note that the sessions will be recorded by default; only the active speaker and screen sharing will be recorded. If you do not wish to be recorded, please let the session chair know, so that they can pause the recording.
All recordings will remain accessible online for 7 days after the end of the conference. Unfortunately, it is not possible to download these recordings.

Face-to-face Component

Due to the current COVID-19 restrictions, only doubly-vaccinated participants may take part in the face-to-face component.
Please complete the form at `https://forms.gle/ZPf8oiJJoYWWUETTA` to fill in your contact details, and to indicate which sessions you would like to attend.
Selected sessions will be broadcast in various venues of the NuSpace building, and speakers are able to present their talks in these venues in front of a live audience. Such talks will be simultaneously broadcast in Zoom Events.

Instructions for Speakers

Please prepare your talk in a form that can be presented online via screen sharing in Zoom. Beamer slides, or writing with a stylus are good options. If presenting face-to-face, the easiest option is for you to connect and screen-share via Zoom while speaking in the live venue. Optionally, you can use the Zoom-connected lectern PCs in the venues; bring a USB stick with your slides.

Discord Server

A Discord server has been set up for this conference. In the server you can join various text, voice or video channels, including one channel for each conference session. You can also choose to allow Discord to send push notifications to your mobile device, which is the fastest way to receive conference updates. Of course, Discord is entirely optional and all announcements will also appear on the conference webpage: `https://carma.edu.au/meetings/austms2021`
To join the Discord server, click on the following link: `https://discord.gg/9JSGdzsCZb`
Once you have signed up to Discord, you will enter the how-to channel, which displays instruction on how to verify your identity. To do so, you will need your 4-digit registration Id (which was emailed to you) as well as the email address with which you registered for the conference.

Gather.town

A Gather.town server has been set up to allow participants to mingle in a virtual environment. It includes private space and shared whiteboards for mathematical discussions. A meet & greet is scheduled for Monday evening at 7pm in gather.town. The space will remain open throughout the conference, so please pop in to meet your colleagues, especially during the breaks.
To enter gather.town, use the following link: `https://gather.town/events/pcO3SWuiVfic1XEV0QDz`

Conference Sponsors

Conference Program

Overview of the Academic Program

There are 301 talks, including 9 plenary lectures and 21 special sessions. The Education Afternoon on Wednesday comprises 4 talks accessible to a general mathematical audience. There is a panel discussion on The State of Mathematics at Australian Universities on Tuesday 1.30pm, and one on Equity, Diversity and Inclusion on Wednesday 11am.

▷ Conference Timetable – page 4

Plenary Lecturers

Robyn Araujo (QUT)
Richard Brent (ANU) *Borwein Lecture*
Jennifer Flegg (University of Melbourne) *ANZIAM lecturer*
Chris Matthews (UTS) *Dr Mandawuy Yunupingu lecturer*
Emily Riehl (Johns Hopkins University, USA) *Hanna Neumann lecturer*
Zeev Rudnick (Tel-Aviv University, Israel)
Susan Scott (ANU) *ANZAMP lecturer*
Joaquim Serra (ETH Zurich, Switzerland) *ECR lecturer*
Gang Tian (Peking University, China, and Princeton University, USA)

▷ Timetable of Plenary Lectures – page 11

Special Sessions

Education Afternoon

Erik Stern (Weber State University, USA)
Cassandra Portelli (Hunter School of Performing Arts)
Chris Tisdell (UNSW)
Linda McIver (Australian Data Science Education Institute)

▷ Timetable for Education Afternoon – page 34

Social Program

- Monday 7-8pm
  Meet & Greet
  Gather.town
- Monday 7.30-10pm
  WIMSIG Dinner
  Noah's on the Beach
- Thursday 5pm
  Foreshore walk
  Meet on Ground Floor
- Thursday, 6.30pm
  Conference Dinner
  Customs House Hotel
  gather.town

Annual General Meeting of the Society

- Thursday 4pm
  Annual General Meeting
  Zoom / XG-18

Emergency Contacts

Florian Breuer florian.breuer@newcastle.edu.au - Conference Director
Juliane Turner juliane.turner@newcastle.edu.au - Conference Secretary & Treasurer
David Allingham david.allingham@newcastle.edu.au - Zoom Events organiser
John Banks john.banks@unimelb.edu.au - Registration system

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gather.town: `https://gather.town/events/pc03SWuiVfic1XEV0QDz`
City Campus Map (with NuSpace floorplans): `https://www.newcastle.edu.au/campus-life/newcastle/newcastle-city/map`

Plenary Lectures in Zoom Events and NuSpace

▷ Tue 7 December

11:30 Gang Tian (Peking University)
Ricci flow on Fano manifolds
(p. 85)

18:00 Zeev Rudnick (Tel Aviv University)
Beyond uniform distribution
(p. 84)

▷ Wed 8 December

09:30 Emily Riehl (Johns Hopkins University)
From path induction to arrow induction and the dependent Yoneda lemma
(p. 84)

13:00 Richard P Brent (Australian National University)
Jonathan Borwein: Life and Legacy
(p. 83)

17:00 Chris Matthews (Aboriginal and Torres Strait Islander Mathematics Alliance)
My Journey as a Goori Mathematician
(p. 84)

▷ Thu 9 December

09:30 Susan Scott (Australian National University)
Singularities of Space-Time
(p. 84)

11:00 Jennifer Flegg (The University of Melbourne)
Data-driven mathematical models for malaria response
(p. 83)

▷ Fri 10 December

09:00 Joaquim Serra (ETH Zurich)
Fractional minimal surfaces: an invitation for the skeptics (and the convinced)
(p. 85)

11:00 Robyn Patrice Araujo (Queensland University of Technology)
Universal robustness-promoting structures in biochemical reaction networks
(p. 83)

Session 1: Algebra

Organisers: Michal Ferov, George Willis

Keynote Talks

▷ Tue 7 December

16:00 Giles Gardam (University of Muenster)
The Kaplansky conjectures
(p. 87)

▷ Wed 8 December

16:00 David Harvey (University of New South Wales)
Fast multiplication: some unsolved problems
(p. 88)

▷ Fri 10 December

13:00 Marcy Robertson (The University of Melbourne)
Automorphisms of seemed surfaces, modular operads and Galois actions
(p. 90)

Contributed Talks

▷ Tue 7 December

14:30 Saul Freedman (University of St Andrews)
The intersection graph of a finite simple group
(p. 87)

15:00 Colin David Reid (The University of Newcastle)
Building trees out of compact subgroups
(p. 90)

17:00 Matthew Conder (The University of Auckland)
Discrete and free groups acting on locally finite trees
(p. 86)

17:30 Aparna Pradeep Vadakke Kovilakam (Cochin University of Science and Technology)
Visualization for Petrov's odd unitary group
(p. 91)

19:00 Roman Gorazd (The University of Newcastle)
Higman-Thompson groups of directed label-regular trees
(p. 88)

19:30 Sebastian Bischof (Justus Liebig Universität Gießen)
Construction of RGD-systems over F_2
(p. 85)

▷ Wed 8 December

08:30 Yudhistira Andersen Bunjamin (UNSW Sydney)
Isomorphisms and automorphisms of group divisible designs
(p. 86)

09:00 João Vitor Pinto e Silva (The University of Newcastle)
Matrices indexed by (possibly infinite) partially ordered sets
(p. 90)

18:00 Giacomo Tendas (Macquarie University)
On continuity of functors between locally presentable categories
(p. 90)

18:30 Su Yuan Chan (Deakin University)
Bounds on the Inducibility of Double Loop Graphs
(p. 86)

19:00 Riya Jose (Cochin University of Science and Technology)
Chain Bundles and Category of Chains
(p. 88)

19:30 Carmine Monetta (University of Salerno)
p-nilpotency criteria for some commutator subgroups of a finite group
(p. 89)

▷ Fri 10 December

08:00 Heiko Dietrich (Monash University)
On a duality for codes over non-abelian groups
(p. 86)

08:30 Intan Muchtadi-Alamsyah (Institut Teknologi Bandung (ITB))
On Orthogonal Theta-Circulant MDS Matrices
(p. 89)

14:00 James East (Western Sydney University)
Congruences of twisted partition monoids
(p. 87)

14:30 Marcel Jackson (La Trobe University)
Presenting the Demon
(p. 88)

15:00 Adam Piggott (Australian National University)
Groups presented by length-reducing rewriting systems
(p. 89)

16:00 Michal Ferov (The University of Newcastle)
Automorphism groups of Cayley graphs of Coxeter groups: when are they discrete?
(p. 87)

16:30 Murray Elder (University of Technology Sydney)
Equations in hyperbolic groups
(p. 87)

17:00 Mihai-Silviu Lazorec ("Alexandru Ioan Cuza" University of Iasi)
Minimum/Maximum values of the number of cyclic subgroups of a finite p-group
(p. 89)

Session 2: Applied and Industrial Mathematics

Organisers: Mark Nelson, Harvinder Sidhu, Simon Watt

Keynote Talks

▷ Fri 10 December

13:00 Philip Broadbridge (La Trobe University)
Conditionally integrable reaction-diffusion systems: Lotka-Volterra Type Predator-Prey
(p. 93)

Contributed Talks

▷ Tue 7 December

14:30 Eva Stadler (UNSW Sydney)
Population and temporal heterogeneity in recurrent malaria infections
(p. 96)

15:00 Lucinda Harrison (The University of Melbourne)
A flexible framework for surveillance of Plasmodium knowlesi malaria in Indonesia
(p. 94)

16:00 Xin An (UNSW Sydney)
Diabetic retinopathy early detection assisted by PDE constrained optimisation
(p. 91)

16:30 Joshua Stevenson (University of Tasmania)
Circular genome rearrangement models
(p. 97)

17:00 Md Nurul Anwar (The University of Melbourne)
A multiscale mathematical model of Plasmodium vivax transmission
(p. 92)

17:30 Maia Nikolova Angelova (Deakin University)
Delay differential equations model of glucose- insulin dynamics: Towards a digital twin model
(p. 91)

19:00 John bailie John bailie (The University of Auckland)
Bifurcation analysis of a conceptual model for the Atlantic Meridional Overturning Circulation
(p. 95)

19:30 Kyle Jacob Stevens (The University of Newcastle)
More continuum modelling with the Lennard-Jones potential
(p. 97)

▷ Thu 9 December

08:00 Edward Bissaker (The University of Newcastle)
An Informed Simulated Annealing method for coke reconstruction.
(p. 93)

08:30 Matthew Berry (University of Wollongong)
Understanding the impact of Hotspots on the self-heating behaviour of Industrial stockpiles
(p. 93)

09:00 Mona Bahri (UNSW Canberra)
Time Series Forecasting Using Smoothing Ensemble Empirical Mode Decomposition and Machine Learning Techniques
(p. 92)

13:00 Diane Donovan (The University of Queensland)
Advanced Mathematical Modelling For Improved Learning Cycle Assessment Natural Gas Wells' Performance
(p. 93)

13:30 Thiansiri Luangwilai (Navaminda Kasatriyadhiraj Royal Thai Air Force Academy)
Understanding the factors affecting the self-heating process of compost piles – two-dimensional analysis
(p. 95)

14:00 Lucy Ham (The University of Melbourne)
Unravelling the correlation structure of noise in molecular pathways
(p. 94)

14:30 Venta Terauds (University of Tasmania)
Genome algebras in action
(p. 97)

▷ Fri 10 December

14:00 Luke Bennetts (The University of Adelaide)
Rayleigh–Bloch waves above the cut-off
(p. 92)

14:30 Vassili Kitsios (CSIRO)
Data driven stochastic parameterisation of the subgrid interactions between eddies, climate and topography in quasi-geostrophic simulations of the Antarctic Circumpolar Current
(p. 95)

15:00 Mark Nelson (University of Wollongong)
Time of death: linking differential equations and linear regression
(p. 96)

Session 3: Computational Mathematics

Organisers: Bishnu Lamichhane, Quoc Thong Le Gia

Keynote Talks

▷ Wed 8 December

16:00 Santiago Badia (Monash University)
Recent advances in unfitted finite element methods
(p. 98)

Contributed Talks

▷ Tue 7 December

14:30 Jerome Droniou (Monash University)
An arbitrary-order robust polygonal scheme for the Reissner-Mindlin plate problem
(p. 99)

15:00 Liam Yemm (Monash University)
An Extended Hybrid High-Order method for the Poisson problem with singular solutions
(p. 104)

16:00 Neil Kristofer Dizon (The University of Newcastle)
Quaternion-valued wavelets in colour image processing
(p. 99)

16:30 Frederick Fung (Australian National University)
On accurate numerical simulations of nonlinear dynamic shear ruptures on non-planar faults embedded in 3D elastic solids using upwind finite difference methods
(p. 100)

17:00 Chris Christopher Williams (None)
Dispersion relation preserving schemes
(p. 98)

17:30 Hailong Guo (The University of Melbourne)
Deep unfitted Nitsche method for elliptic interface problems
(p. 101)

▷ Wed 8 December

08:00 Bishnu Lamichhane (The University of Newcastle)
A Simple Numerical Scheme for Reissner-Mindlin Plate Equations
(p. 101)

08:30 Jordan Shaw-Carmody (The University of Newcastle)
Local projection stabilisation of convection dominated problems using a biorthogonal system and adaptive finite element method
(p. 103)

09:00 Sean McGowan (The University of Adelaide)
Model-free prediction of noisy, chaotic systems
(p. 102)

14:00 Ian Sloan (University of New South Wales)
So you have shown that two function spaces are equivalent? Why does it matter? Who cares?
(p. 103)

14:30 Alexander Gilbert (University of New South Wales)
Density estimation using quasi-Monte Carlo methods with preintegration
(p. 100)

15:00 Abirami Srikumar (UNSW Sydney)
Approximating distribution functions for solutions to partial differential equations with random coefficients using quasi-Monte Carlo methods and preintegration
(p. 103)

▷ Thu 9 December

13:00 William McLean (University of New South Wales)
Superconvergence effects for discontinuous Galerkin time stepping
(p. 102)

13:30 Geordie Drummond McBain (None)
Compressed vector Prony analysis for supercritical Hopf bifurcations in computational fluid dynamics
(p. 101)

14:00 Vivien Challis (Queensland University of Technology)
Multi-objective structural optimisation of piezoelectric materials
(p. 98)

14:30 Kenneth Duru (The Australian National University)
Upwind Summation By Parts Finite Difference Methods for Large Scale Elastic Wave Simulations In Complex Geometries
(p. 100)

15:00 Rob Corless (University of Western Ontario)
Hybrid symbolic-numeric computation for Bohemian matrices
(p. 99)

▷ Fri 10 December

13:00 Tareq Alodat (University of New South Wales)
Limit theorems for filtered long-range dependent random fields
(p. 97)

13:30 Michael Assis (The University of Melbourne)
An origami Universal Turing machine
(p. 98)

14:00 Quoc Thong Le Gia (University of New South Wales)
Solving partial differential equations on spheres using neural networks
(p. 101)

Session 4: Cryptography, Coding Theory and Related Topics

Organisers: Ajit Kumar Keshri, Veronika Kuchta, Bimal Kumar Mishra, Ron Steinfeld

Keynote Talks

▷ Wed 8 December

08:00 Jeffrey Hoffstein (Brown University)
Public key cryptography and lattices with a ring structure
(p. 105)

Contributed Talks

▷ Wed 8 December

09:00 Muhammad Nauman Khan (RMIT University)
Classical to Post-Quantum ABE-IBE Proxy Re-Encryption Scheme
(p. 105)

14:00 Youming Qiao (University of Technology Sydney)
Revisiting signature schemes based on isomorphism problems
(p. 106)

14:30 Muhammed Esgin (Monash University)
Math & Crypto: How CRT is Used to Solve Interesting Crypto Problems
(p. 104)

15:00 Robby McKilliam (Myriota)
Finding shortest and closest vectors in a lattice of Voronoi's first kind
(p. 106)

16:00 Travis Scrimshaw (Osaka City University)
Computational Problems from Combinatorics and Algebra
(p. 107)

16:30 Vladimir Shpilrain (City University of New York)
Redactable blockchains
(p. 107)

▷ Thu 9 December

08:00 Swastik Kopparty (University of Toronto)
Proving Proximity to Polynomials
(p. 105)

08:30 Felipe Voloch (University of Canterbury)
Locally recoverable codes and algebraic surfaces
(p. 108)

09:00 Son Hoang Dau (RMIT University)
On a Tree Coloring Problem and Its Application in Private Data Retrieval from a Merkle Tree
(p. 104)

13:00 Geetika Verma (RMIT University)
Swarm Randon Number Generator for use in secret sharing
(p. 107)

13:30 Matthew Paul Skerritt (RMIT University)
Threshold Ed25519 Digital Signatures
(p. 107)

14:00 Anthony Overmars (None)
DRS Factorization Method
(p. 106)

Session 5: Dynamical Systems and Ergodic Theory

Organisers: Jason Atnip, Gary Froyland

Contributed Talks

▷ Tue 7 December

14:30 Philipp Braun (Australian National University)
Stability of Dynamical Systems and Lyapunov-like Characterizations
(p. 108)

15:00 Leo Jiang (University of Toronto)
Configurations in trees of positive dimension
(p. 110)

16:00 Claudio Arancibia-Ibarra (Queensland University of Technology)
Non-Stationary Patterns in a three-component FitzHugh-Nagumo System
(p. 108)

16:30 Caroline Wormell (CNRS)
Linear response in higher dimensions and mixing of Cantor sets
(p. 112)

▷ Wed 8 December

08:00 Hinke Osinga (The University of Auckland)
Phase resetting as a two-point boundary value problem
(p. 111)

08:30 Sean Gasiorek (The University of Sydney)
Linear Stability of Periodic Trajectories in Inverse Magnetic Billiards
(p. 109)

09:00 Mitch Curran (The University of Sydney)
Applying the Maslov index to the Nonlinear Schrodinger equation
(p. 109)

▷ Thu 9 December

08:00 Bernd Krauskopf (University of Auckland)
The geometry of a blender: the case of spaghetti in a can
(p. 110)

08:30 Kamil Bulinski (The University of Sydney)
Reconstructing a minimal topological dynamical system from a set of return times
(p. 109)

09:00 Eric William Hester (University of California Los Angeles)
On the stability of isothermal shocks in black hole accretion disks
(p. 110)

13:00 Carlo Laing (Massey University)
Periodic solutions of a theta neuron subject to delayed self-feedback
(p. 111)

13:30 Alexander Fish (The University of Sydney)
Sets of transfer times with small densities
(p. 109)

14:00 Cecilia Gonzalez-Tokman (The University of Queensland)
Quenched results for random open and closed dynamical systems
(p. 110)

14:30 Andy Hammerlindl (Monash University)
Ergodicity and accessibility in dimension 3
(p. 110)

15:00 John Roberts (University of New South Wales)
A combinatorial model for the dynamics of birational maps over finite fields
(p. 111)

Session 6: Education Afternoon

Organisers: Judy-anne Osborn

Keynote Talks

▷ Wed 8 December

14:00 Erik Stern (Weber State University)
Do the Same, Do the Opposite: An Intro to the Physical-Conceptual Connection
(p. 112)

Contributed Talks

▷ Wed 8 December

15:00 Cassandra Portelli (Hunter School of Performing Arts)
Spaced Learning
(p. 112)

16:00 Chris Tisdell (University of New South Wales)
Beyond the Compass: Geometric Constructions with Circle Templates
(p. 113)

16:30 Linda McIver (Australian Data Science Education Institute)
A Quick and Easy Introduction to Classroom Data Science
(p. 112)

Session 7: Equity, Diversity and Inclusivity in Mathematics

Organisers: Matthew Mack, Judy-anne Osborn, Aidan Sims

Contributed Talks

- ▷ Thu 9 December
  - 14:30 Joanne Hall (Royal Melbourne Institute of Technology)
    Gender differences in the skills sought when recruiting for graduate roles
    (p. 114)
  - 15:00 Yudhistira Andersen Bunjamin (UNSW Sydney)
    Designing mathematics outreach workshops for operational versatility
    (p. 113)

Session 8: Geometry with Symmetries

Organisers: Owen Dearricott, Ramiro Augusto Lafuente

Keynote Talks

▷ Thu 9 December

13:00 Guofang Wei (University of California, Santa Barbara)
Examples of Ricci limit spaces with non-integer Hausdorff dimension
(p. 116)

Contributed Talks

▷ Tue 7 December

14:30 Artem Pulemotov (The University of Queensland)
Mountain pass approach to the prescribed Ricci curvature problem
(p. 116)

15:00 Timothy Buttsworth (The University of Queensland)
SU(2)-invariant steady Ricci solitons on cohomogeneity one four-manifolds
(p. 114)

16:00 Kyle Broder (The Australian National University)
Recent developments in the curvature of Hermitian manifolds
(p. 114)

16:30 James Stanfield (None)
Positive Hermitian curvature flow on nilpotent and almost-abelian complex Lie groups
(p. 116)

17:00 Valentina-Mira Wheeler (University of Wollongong)
Curve diffusion and free elastic flows on parallel lines
(p. 117)

17:30 Haotian Wu (The University of Sydney)
A numerical stability analysis of mean curvature flow of noncompact hypersurfaces with Type-II curvature blowup
(p. 117)

▷ Wed 8 December

14:00 Peter Petersen (University of California Los Angeles)
New Curvature Conditions for the Bochner Technique
(p. 115)

15:00 Yuri Nikolayevsky (La Trobe University)
Einstein hypersurfaces in irreducible symmetric spaces
(p. 115)

16:00 Mat Langford (The University of Newcastle)
Symmetric and asymmetric ancient mean curvature flows
(p. 115)

16:30 Benjamin Blake McMillan (The University of Adelaide)
The secondary characteristic classes of singular foliations
(p. 115)

▷ Thu 9 December

14:00 Jonathan Julian Zhu (Australian National University)
Min-max theory for capillary surfaces
(p. 117)

14:30 Gerd Schmalz (University of New England)
CR embeddings of CR manifolds with complex infinitesimal symmetries
(p. 116)

15:00 Emma Carberry (The University of Sydney)
Blowing up Sequences of Constant Mean Curvature Tori in Euclidean 3-Space to Yield Minimal Surfaces
(p. 114)

Session 9: Geometric and Harmonic Analysis

Organisers: Kwok-Kun Kwong, Po-Lam Yung

Contributed Talks

▷ Tue 7 December

16:00 Glen Edward Wheeler (University of Wollongong)
On the entropy flow
(p. 120)

16:30 Hosea Wondo (The University of Sydney)
The Continuity Method on Kahler Manifolds
(p. 120)

17:00 Adam Sikora (Macquarie University)
Vertical and horizontal Square Functions on a Class of Non-Doubling Manifolds
(p. 119)

17:30 Ji Li (Macquarie University)
Singular value estimates of commutators of Calderon–Zygmund operators— recent progresses on stratified Lie groups
(p. 119)

▷ Wed 8 December

18:00 Sanghyuk Lee (Seoul National University)
Maximal and regularity estimates for averages over curves
(p. 119)

18:30 Neal Bez (Saitama University)
Regularized inverse Brascamp-Lieb inequalities
(p. 117)

19:00 Jongchon Kim (City University of Hong Kong)
Geometric maximal functions associated with spheres
(p. 118)

19:30 Keith Rogers (Spanish National Research Council)
Improved bounds for the Kakeya maximal conjecture using semialgebraic geometry
(p. 119)

▷ Thu 9 December

14:00 Yong Wei (University of Science and Technology of China)
Weighted geometric inequalities for hypersurfaces in space forms
(p. 120)

14:30 Zhou Zhang (The University of Sydney)
Stability of Volume Preserving Mean Curvature Flow in Hyperbolic Space
(p. 120)

15:00 Man-Chun Lee (The Chinese University of Hong Kong)
continuous metric and scalar curvature
(p. 118)

▷ Fri 10 December

16:00 Enrico Valdinoci (The University of Western Australia)
Long-range phase coexistence models and the nonlocal Allen-Cahn equation
(p. 120)

16:30 Serena Dipierro (The University of Western Australia)
The stickiness property of nonlocal minimal surfaces
(p. 117)

17:00 Daniel Hauer (The University of Sydney)
Functional Calculus via the extension technique: a first hitting time approach
(p. 118)

17:30 Jeffrey Hogan (The University of Newcastle)
Clifford translation and bandpass bases
(p. 118)

Session 10: Harmonic Analysis and Hyperbolic PDEs

Organisers: The Bui, Zihua Guo, Ji Li

Keynote Talks

▷ Wed 8 December

08:30 Leo Tzou (The University of Sydney)
Single Observer Tomography via Nonlinear Waves
(p. 123)

14:00 Yihong Du (University of New England)
Long-time dynamics of the Fisher-KPP nonlocal diffusion equation with free boundary
(p. 121)

Contributed Talks

▷ Wed 8 December

15:00 Zijun Chen (Monash University)
Local well-posedness for the Zakharov system in dimension d=2, 3
(p. 121)

16:00 Antoine Gansemer (Australian National University)
Exact Egorov theorem
(p. 121)

16:30 Quoc Hung NGUYEN (Chinese Academy of Sciences)
Well-posedness of the Muskat and Peskin problems
(p. 122)

▷ Fri 10 December

10:00 Arunmaran Mahenthiram (University of South Australia)
The harmonic-measure distribution functions of multiply connected regions
(p. 122)

13:00 xiao xiong (Harbin Institute of Technology)
Schatten properties of quantum derivatives on quantum tori
(p. 123)

13:30 Chun-Yen Shen (National Taiwan University)
Mattila-Sjolin distance problem for product sets
(p. 123)

14:00 Himani Sharma (The Australian National University)
Pseudodifferential calculi using Weyl pairs on L^p
(p. 122)

14:30 Hamed Baghal Ghaffari (The University of Newcastle)
New Properties of Clifford Prolate Spheroidal Wave Functions (CPSWFs)
(p. 121)

Session 11: Indiginising University Mathematics

Organisers: Michael Donovan, Judy-anne Osborn

Contributed Talks

- ▷ Thu 9 December

  14:00 Maureen Edwards (University of Wollongong)
  Jindaola
  (p. 123)

Session 12: Integrable systems and Mathematical Physics

Organisers: Nalini Joshi, Pieter Roffelsen, Yang Shi

Keynote Talks

- ▷ Wed 8 December

  18:00 Oleg Lisovyy (Université de Tours)
  From Painlevé functions to Heun accessory parameters and back
  (p. 126)

Contributed Talks

- ▷ Tue 7 December

  16:00 David Pfefferlé (The University of Western Australia)
  Relative helicity formulae in magnetostatics from cohomological methods
  (p. 127)

  16:30 David Perrella (The University of Western Australia)
  Integrability of normal distributions: A Stefan-Sussmann theorem and neat foliations by manifolds with boundary
  (p. 127)

  17:00 Benjamin Morris (Australian National University)
  Towards a factorised solution of the Yang-Baxter equation with $U_q(\mathfrak{sl}_n)$ symmetry
  (p. 126)

  17:30 Andrew Kels (International School for Advanced Studies (SISSA))
  16 new Yang-Baxter maps
  (p. 125)

- ▷ Wed 8 December

  14:00 Nalini Joshi (The University of Sydney)
  Motion and monodromy
  (p. 125)

  14:30 Joshua Holroyd (The University of Sydney)
  Asymptotic Analysis and Special Solutions of a Family of Painlevé-Like Equations
  (p. 124)

  15:00 Tomas Lasic Latimer (The University of Sydney)
  Asymptotic behaviours of q-orthogonal polynomials from a q-Riemann Hilbert Problem
  (p. 125)

  16:00 Milena Radnovic (The University of Sydney)
  Resonances of elliptical billiards
  (p. 127)

  16:30 Mitchell Ryan (The University of Queensland)
  The Supersymmetric Box-Ball System
  (p. 127)

- ▷ Thu 9 December

  08:00 Ian Marquette (University of Queensland)
  Painlevé VI, rational potentials and cubic algebras
  (p. 126)

09:00 Vishnu Mangalath (None)
Singularities of Whitham Deformations
(p. 126)

13:30 Sean Gasiorek (The University of Sydney)
Minkowski Billiards on the Hyperboloid of One Sheet
(p. 124)

14:00 Chris Bourne (Tohoku University)
Symmetry protected topological (SPT) phases of infinite fermion chains
(p. 124)

14:30 Norman Do (Monash University)
The topological vertex and the infinite wedge
(p. 124)

15:00 Yury Stepanyants (University of Southern Queensland)
Lump interactions with plane solitons
(p. 128)

Session 13: Mathematics Education

Organisers: Carolyn Kennett, Judy-anne Osborn, Leesa Sidhu, Chris Tisdell

Keynote Talks

▷ Tue 7 December

17:00 Antony Edwards (Swinburne University of Technology)
Evidence bases in Mathematics Education
(p. 129)

Contributed Talks

▷ Tue 7 December

16:00 Adam Piggott (Australian National University)
Engaging high-achievers through weekly authentic assessment tasks
(p. 130)

16:30 Julia Collins (Edith Cowan University)
Student and staff approaches to academic integrity in calculation-based assessments
(p. 128)

▷ Fri 10 December

13:00 David Yost (Federation University Australia)
Contrarian calculus
(p. 132)

13:30 Zsuzsanna Dancso (The University of Sydney)
Online engagement in advanced 2nd year mathematics
(p. 128)

14:00 Attila Egri-Nagy (Akita International University)
Flat Curriculum with Self-Contained Micro Topics
(p. 129)

14:30 Frank Valckenborgh (Macquarie University)
Reigniting mathematical and statistical thinking for final year science students
(p. 131)

15:00 George Papadopoulos (The University of Sydney)
Student Perspectives on Summer School versus term-time for Undergraduate Mathematics
(p. 130)

16:00 Leesa Sidhu (University of New South Wales Canberra)
Applying the “Care Factor” in the Maths and Stats Classroom
(p. 130)

16:30 Ava Greenwood (The University of Queensland)
Perspectives on partnership: exploring feedback opportunities for mathematics tutors through student-staff partnership
(p. 129)

17:00 Deborah Jackson (La Trobe University)
Looking for answers
(p. 130)

17:30 Chris Tisdell (University of New South Wales)
AustMS Accreditation of Mathematics Degrees and Programs

(p. 131)

Session 14: Number Theory and Algebraic Geometry

Organisers: Mumtaz Hussain, Anna Puskas

Keynote Talks

▷ Tue 7 December

14:30 Igor Shparlinski (UNSW Sydney)
Pseudorandomness of Kloosterman and Salie Sums
(p. 135)

▷ Wed 8 December

14:00 Dzmitry Badziahin (The University of Sydney)
Uniform rational approximation to a number and its consecutive powers
(p. 132)

Contributed Talks

▷ Tue 7 December

16:00 Matthew Paul Skerritt (RMIT University)
Computing Quadratic Integer Relations
(p. 136)

16:30 Shehzad Shabbirbhai Hathi (UNSW Canberra)
Oscillations in Mertens' product formula for number fields
(p. 134)

17:00 Ethan Simpson Lee (UNSW Canberra)
Explicit Estimates for the Residue of the Dedekind zeta-function
(p. 135)

17:30 Aleksander Simonic (University of New South Wales Canberra)
Effective conditional estimates for the argument of ζ on the critical line with applications
(p. 135)

19:00 Daniel Johnston (UNSW Canberra)
Improving bounds on prime counting functions
(p. 135)

▷ Wed 8 December

15:00 Ayreena Bakhtawar (UNSW Sydney)
Continued fractions and Improvements to Dirichlet's theorem
(p. 132)

16:00 Timothy Trudgian (UNSW Canberra)
An apparent bias? Of course: fake mu's!
(p. 136)

16:30 Valeriia Starichkova (UNSW Canberra)
On explicit lower bounds for L-functions.
(p. 136)

18:00 Michaela Cully-Hugill (University of New South Wales Canberra)
Primes between powers
(p. 133)

18:30 Matteo Bordignon (University of New South Wales Canberra)
An explicit version of Chen's theorem
(p. 133)

19:00 Forrest James Francis (Australian Defence Force Academy)
Explicit Estimates for Dirichlet L-functions
(p. 133)

19:30 Hayder Hashim (Kufa University, Faculty of Computer Science and Mathematics)
Curious properties of generalized Lucas numbers
(p. 133)

▷ Fri 10 December

13:00 Kevin Fergusson (Bond University)
Partitions into k-th Powers
(p. 133)

13:30 Randell Heyman (University of New South Wales)
Primes in floor function sets and sequences
(p. 134)

14:00 Lukas Zobernig (The University of Auckland)
Genus 2 Curves in Small Characteristic
(p. 136)

14:30 Alina Ostafe (University of New South Wales)
On a Problem of Lang for Matrix Polynomials
(p. 135)

Session 15: Non-commutative Geometry and Operator Algebras

Organisers: Hao Guo, Abraham Ng, Adam Rennie

Keynote Talks

▷ Wed 8 December

14:00 Mathai Varghese (The University of Adelaide)
Witten Genus and Elliptic genera for proper actions
(p. 139)

Contributed Talks

▷ Wed 8 December

15:00 Lukas Anagnostou (The University of Melbourne)
Characterising Supermanifolds
(p. 137)

16:00 Alan Stoneham (UNSW Sydney)
A generalisation of the spectral theorem for normal operators
(p. 139)

16:30 Ada Masters (None)
Commutativity and geometry
(p. 137)

18:00 Angus Alexander (University of Wollongong)
Levinson's Theorem as an index pairing
(p. 137)

18:30 Rafael Rafael Pereira Lima (Victoria University of Wellington)
AFE property for the Deaconu-Renault groupoid
(p. 138)

19:00 Joel Zimmerman (University of Wollongong)
Fell Bundle Models for C-algebras.*
(p. 139)

19:30 Nicholas Seaton (University of Wollongong)
The Brauer group for Fell algebras.
(p. 138)

▷ Thu 9 December

13:00 Chris Bourne (Tohoku University)
Locally equivalent quasifree states and the coarse index
(p. 137)

13:30 Alexander Mundey (University of Wollongong)
Perfecting noncommutative topology
(p. 137)

14:00 Abraham Ng (University of Wollongong)
Stably finite extensions of rank-2 graph C-algebras*
(p. 138)

14:30 Aidan Sims (University of Wollongong)
Graded KK-groups for graph algebras
(p. 138)

Session 16: Optimisation

Organisers: Thi Hoa Bui, Reinier Diaz Millan, Scott Boivin Lindstrom

Keynote Talks

▷ Wed 8 December

19:00 Radu Ioan Bot (University of Vienna)
Continuous time approaches to structured convex minimization problems
(p. 140)

▷ Thu 9 December

08:00 Levent Tuncel (University of Waterloo)
Mathematical Foundations of Primal-Dual Algorithms for Convex Optimisation
(p. 144)

Contributed Talks

▷ Tue 7 December

14:30 Matthew Tam (The University of Melbourne)
Can we do better than the product space?
(p. 144)

15:00 Lien Nguyen (RMIT University)
Fixed-Time Gradient Dynamics with Time-Varying Coefficients for Continuous-Time Optimization
(p. 142)

16:00 Alexander Kruger (Federation University Australia)
A Radius Theorem for Metric Subregularity
(p. 141)

16:30 Bethany Caldwell (University of South Australia)
Splitting and projection methods for control-constrained linear-quadratic optimal control problems
(p. 140)

17:00 Xuemei Liu (University of South Australia)
A Primal—Dual Penalty Algorithm for Optimal Control of the Double Integrator
(p. 142)

17:30 Andrew Craig Eberhard (RMIT University)
Monotone Operators and Closures Operations for convex sets in XX^*.
(p. 141)

▷ Wed 8 December

08:30 Thi Hoa Bui (Curtin University)
Solving nonlinear binary optimisation with cutting planes
(p. 140)

09:00 Sona Taheri (Royal Melbourne Institute of Technology)
Nonsmooth DC optimization-based piecewise linear L1-regression
(p. 144)

14:30 Vinesha Peiris (Swinburne University of Technology)
Rational activation functions in neural networks with uniform norm based loss functions and its application in classification.

(p. 142)

15:00 Ponpot Jartnillaphand (Curtin University)
Logic-based Benders' Decomposition for Crew Scheduling in maintenance operation
(p. 141)

16:00 Julien Ugon (Deakin University)
Flexible rational approximation for matrix functions
(p. 145)

16:30 Daniel Uteda (The University of Melbourne)
The Bregman Golden Ratio Algorithm for Min-Max Optimisation
(p. 145)

18:00 Lindon Roberts (Australian National University)
Derivative-Free Optimization with Convex Constraints
(p. 143)

18:30 James Saunderson (Monash University)
A convex form that is not a sum of squares
(p. 143)

▷ Thu 9 December

09:00 Hui Ouyang (University of British Columbia, Okanagan)
Convergence of generalized proximal point algorithms
(p. 142)

13:00 Nadia Sukhorukova (Swinburne University of Technology)
Approximations in the form of quasilinear functions
(p. 143)

13:30 Erchuan Zhang (Edith Cowan University)
Finding geodesics joining given points
(p. 145)

14:00 Adil Bagirov (Federation University Australia)
An augmented subgradient method for nonsmooth DC optimization
(p. 139)

14:30 Fred Roosta (University of Queensland)
Invexifying Regularization of Non-Linear Least-Squares Problems
(p. 143)

15:00 Scott Boivin Lindstrom (Curtin University)
A primal/dual computable approach to improving spiraling algorithms, based on minimizing spherical surrogates for Lyapunov functions
(p. 141)

Session 17: Partial Differential Equations: From Theory to Applications

Organisers: Giorgio Poggesi, Enrico Valdinoci

Contributed Talks

▷ Tue 7 December

14:30 Yihong Du (University of New England)
Free Boundary Problems with a Source Term in n-Space Dimension
(p. 146)

16:00 Artem Pulemotov (The University of Queensland)
The prescribed cross curvature problem
(p. 148)

17:00 Giacomin Giovanni (The University of Western Australia)
The Fractional Malmheden Theorem
(p. 146)

19:00 Daniel Hauer (The University of Sydney)
The Dirichlet-to-Neumann operator associated with the 1*-Laplacian and evolution problems*
(p. 147)

▷ Wed 8 December

08:00 Valentina-Mira Wheeler (University of Wollongong)
On the Chen flow
(p. 149)

14:00 Jack Thompson (The University of Western Australia)
On an overdetermined problem involving the fractional Laplacian
(p. 148)

14:30 Jonathan Mui (The University of Sydney)
Asymptotic behaviour of biharmonic heat equations on unbounded domains
(p. 147)

15:00 Timothy Allen Collier (The University of Sydney)
A doubly nonlinear evolution problem involving the fractional p-Laplacian
(p. 146)

16:00 Florica Corina Cirstea (The University of Sydney)
Isolated singularities for nonlinear elliptic equations with a gradient-dependent nonlinearity
(p. 145)

18:00 Glen Edward Wheeler (University of Wollongong)
On the p-elastic flow
(p. 149)

▷ Thu 9 December

08:30 Jiakun Liu (University of Wollongong)
Recent regularity theory of optimal transport and applications
(p. 147)

13:00 Maria Farcaseanu (The University of Sydney)
Classification of singular solutions to nonlinear elliptic equations with a gradient term
(p. 146)

13:30 Xu-Jia Wang (Australian National University)
Regularity of free boundary for the Monge-Ampere obstacle problem
(p. 148)

14:30 Michael Meylan (The University of Newcastle)
Calculating Tsunami Waves using Complex Analysis
(p. 147)

Session 18: Probability Theory and Stochastic Processes

Organisers: Kostya Borovkov, Kazutoshi Yamazaki

Contributed Talks

▷ Tue 7 December

14:30 Aihua Xia (The University of Melbourne)
Geometric sums, size biasing and zero biasing
(p. 155)

15:00 Illia Donhauzer (La Trobe University)
Asymptotics of running maxima for phi-subgaussian random double arrays
(p. 150)

16:00 Tiffany Y. Y. Lo (The University of Melbourne)
The expected degree distribution in transient duplication divergence models
(p. 152)

16:30 ZHIHAO QIAO (The University of Queensland)
Critical parameter configurations of polynomials of a random variable
(p. 154)

17:00 Anant Mathur (UNSW Sydney)
Variance Reduction for Large Matrix Computations
(p. 152)

17:30 Stephen Muirhead (The University of Melbourne)
Mean-field bounds for Poisson-Boolean percolation
(p. 153)

▷ Wed 8 December

14:00 Qihe Tang (University of New South Wales)
Pricing Defaultable Bonds and Credit Derivatives in the Presence of Shock Risk and Unpredictable Recovery
(p. 155)

14:30 Duy-Minh Dang (University of Queensland)
On the distribution of terminal wealth under dynamic mean-variance optimal investment strategies
(p. 150)

15:00 Robert Cantwell (University of New South Wales)
Towards a self-contained theory for stochastics in the complex plane
(p. 149)

16:00 Vincent Liang (The University of Melbourne)
On Markov chain approximations for computing boundary crossing probabilities of diffusion processes
(p. 151)

16:30 Ross McVinish (The University of Queensland)
Dominating stochastic patch occupancy models by independent patches
(p. 152)

▷ Thu 9 December

13:00 Xi Geng (The University of Melbourne)
Precise Local Estimates for Hypoelliptic Differential Equations driven by Fractional Brownian Motion
(p. 151)

13:30 Andriy Olenko (La Trobe University)
Fractional SPDE for Random Tangent Fields on the Sphere
(p. 153)

14:00 Chunxi Jiao (The University of Sydney)
Solution of a stochastic Landau-Lifshitz-Slonczewski equation
(p. 151)

14:30 Robert Charles Griffiths (Monash University)
A class of non-reversible hypercube long-range random walks and Bernoulli autoregression
(p. 151)

15:00 Sarat Babu Moka (Macquarie University)
Graph Coloring via Partial Rejection Sampling
(p. 153)

▷ Fri 10 December

13:00 Nathan Ross (The University of Melbourne)
Gaussian process approximation using Stein's method, with applications to queues
(p. 154)

14:00 Greg Markowsky (Monash University)
On the probability of fast exits and long stays of a planar Brownian motion in simply connected domains
(p. 152)

14:30 Budhi Surya (Victoria University of Wellington)
Maximum likelihood estimation for a general mixture of Markov jump processes
(p. 154)

15:00 Eric C.K. Cheung (UNSW Sydney)
A bivariate Laguerre expansions approach for joint ruin probabilities in a two-dimensional insurance risk process
(p. 150)

16:00 Kostya Borovkov (The University of Melbourne)
Parisian ruin with random deficit-dependent delays for spectrally negative Lévy processes
(p. 149)

16:30 jae kyung woo (University of New South Wales)
Multitype branching process with nonhomogeneous Poisson and contagious Poisson immigration
(p. 155)

17:00 Libo Li (University of New South Wales)
Numerical schemes for jump-extended Constant-Elasticity-of-Variance (CEV) process
(p. 151)

Session 19: Representation Theory

Organisers: Asilata Bapat, Masoud Kamgarpour

Contributed Talks

▷ Tue 7 December

14:30 Daniel Tubbenhauer (The University of Sydney)
Monoidal categories and cryptography
(p. 158)

15:00 Anthony Licata (Australian National University)
q-rational numbers and stability conditions on the A_2 quiver
(p. 157)

16:00 Travis Scrimshaw (Osaka City University)
K-Theoretic Schubert Calculus and Stochastic Processes
(p. 158)

16:30 Joshua Ciappara (The University of Sydney)
Hecke category actions via Smith–Treumann theory
(p. 156)

17:00 Gaston Burrull (The University of Sydney)
Unimodality of Bruhat intervals
(p. 156)

17:30 Ivo De Los Santos Vekemans (Australian National University)
Mackey functors as G-commutative monoids
(p. 158)

▷ Wed 8 December

08:00 Ian Le (Australian National University)
Cluster algebras and mirror symmetry for flag varieties
(p. 157)

08:30 Marijana Butorac (University of Rijeka)
Principal subspaces of standard modules of affine Lie algebra of type $G_2^{(1)}$
(p. 156)

09:00 David Ridout (The University of Melbourne)
A Kazhdan–Lusztig correspondence for a vertex algebra associated to $\mathfrak{sl}_3$
(p. 158)

14:00 GyeongHyeon Nam (The University of Queensland)
Arithmetic geometry of representation varieties with regular monodromy
(p. 157)

14:30 Nick Bridger (University of Queensland)
Arithmetic geometry of characters stacks and their E-polynomials
(p. 156)

15:00 Martin Gossow (The University of Sydney)
Acting by the Long Cycle on the Kazhdan-Lusztig Basis
(p. 157)

Session 20: Topology

Organisers: Bea Bleile, Zsuzsanna Dancso, Jessica Purcell

Keynote Talks

▷ Tue 7 December

16:00 Amnon Neeman (Australian National University)
A counterexample to vanishing conjectures in negative K-theory
(p. 162)

Contributed Talks

▷ Tue 7 December

14:30 Alexander He (The University of Queensland)
Greedy retriangulation of 3-manifolds
(p. 160)

15:00 Emily Thompson (Monash University)
Twisting, ladder graphs and A-polynomials
(p. 162)

▷ Wed 8 December

08:00 Ellena Moskovsky (Monash University)
Fully simple maps and topological recursion
(p. 161)

08:30 Jack Brand (Australian Mathematical Sciences Institute)
Diagrams of Legendrian Knots In Closed Contact Manifolds
(p. 159)

09:00 Roland van der Veen (University of Groningen)
Where do quantum invariants come from?
(p. 162)

14:00 Thiago de Paiva Souza (Monash University)
Hyperbolic knots given by positive braids with at least two full twists
(p. 160)

14:30 Zsuzsanna Dancso (The University of Sydney)
Welded tangles and the Kashiwara-Vergne groups
(p. 160)

15:00 Tamara Hogan (The University of Melbourne)
Symmetries of 3D and 4D expansions
(p. 161)

16:00 Asilata Bapat (Australian National University)
Expansive rigid motions and a piecewise-linear sphere
(p. 159)

16:30 Daniel Mathews (Monash University)
A symplectic basis for 3-manifold triangulations
(p. 161)

▷ Thu 9 December

- 08:00 Sophie Ham (Monash University)
  TBA
  (p. 160)
- 09:00 Jonathan Spreer (The University of Sydney)
  Normal surfaces and the complexity of 3-manifolds
  (p. 162)
- 14:00 Diarmuid Crowley (The University of Melbourne)
  Surface knots and bisections of the 4-sphere
  (p. 159)
- 14:30 José Ayala Hoffmann (The University of Melbourne)
  Gordian unlinks
  (p. 159)
- 15:00 Martin Helmer (Australian National University)
  Conormal Spaces and Whitney Stratifications
  (p. 161)

Session 21: Visualisation and Mathematical Art

Organisers: Katherine Seaton, Matthew Paul Skerritt

Keynote Talks

▷ Fri 10 December

13:00 Daniel Francis Mansfield (University of New South Wales)
The geometry of rectangles in ancient Mesopotamia
(p. 164)

Contributed Talks

▷ Wed 8 December

08:00 Karen Amanda Harris (University of the Arts London)
Creating Non-Digital Maths Art: decisions, discipline and dizzying possibilities
(p. 164)

08:30 Michael Assis (The University of Melbourne)
Functional origami lampshades
(p. 163)

09:00 Bethany Caldwell (University of South Australia)
Visualisations of a generalised Newton method
(p. 163)

▷ Fri 10 December

08:00 Sean Gardiner (UNSW Sydney)
Visual design of an outreach workshop based on bijections
(p. 163)

08:30 Asha Rao (Royal Melbourne Institute of Technology)
Connecting sewing to higher mathematics
(p. 165)

14:00 Katherine Seaton (La Trobe University)
Stitching the wallpaper groups
(p. 165)

14:30 Jo-ann Larkins (Federation University Australia)
Encoding language in mosaic knitting
(p. 164)

15:00 James East (Western Sydney University)
That's not a proof, it's a picture!
(p. 163)

16:00 Katherine Seaton (La Trobe University)
Discussion of Mathematical Art at future AustMS meetings
(p. 165)

Tue 7 December

■ Summary timetable

When	What
09:00–11:00	**Opening Ceremony, AustMS Prizes**
11:00–11:30	Coffee break
11:30–12:30	**Plenary:** Tian – Ricci flow on Fano manifolds (p. 85)
12:30–13:30	Lunch
13:30–14:30	**Panel Discussion: The state of Mathematics at Australian Universities**
14:30–15:30	3 special session talks
14:30–15:00	9 special session talks
15:00–15:30	9 special session talks
15:30–16:00	Break
16:00–17:00	3 special session talks
16:00–16:30	11 special session talks
16:30–17:00	11 special session talks
17:00–18:00	2 special session talks
17:00–17:30	11 special session talks
17:30–18:00	10 special session talks
18:00–19:00	**Plenary:** Rudnick – Beyond uniform distribution (p. 84)
19:00–20:00	Special session talk
19:00–19:30	6 special session talks
19:30–20:00	5 special session talks

■ Non-plenary Sessions

2. Algebra

14:30 Saul Freedman (University of St Andrews)
The intersection graph of a finite simple group
(p. 87)

15:00 Colin David Reid (The University of Newcastle)
Building trees out of compact subgroups
(p. 90)

16:00 Giles Gardam (University of Muenster)
The Kaplansky conjectures
(p. 87)

17:00 Matthew Conder (The University of Auckland)
Discrete and free groups acting on locally finite trees
(p. 86)

17:30 Aparna Pradeep Vadakke Kovilakam (Cochin University of Science and Technology)
Visualization for Petrov's odd unitary group
(p. 91)

19:00 Roman Gorazd (The University of Newcastle)
Higman-Thompson groups of directed label-regular trees
(p. 88)

19:30 Sebastian Bischof (Justus Liebig Universität Gießen)
Construction of RGD-systems over F_2
(p. 85)

3. Applied and Industrial Mathematics

14:30 Eva Stadler (UNSW Sydney)
Population and temporal heterogeneity in recurrent malaria infections
(p. 96)

15:00 Lucinda Harrison (The University of Melbourne)
A flexible framework for surveillance of Plasmodium knowlesi malaria in Indonesia
(p. 94)

16:00 Xin An (UNSW Sydney)
Diabetic retinopathy early detection assisted by PDE constrained optimisation
(p. 91)

16:30 Joshua Stevenson (University of Tasmania)
Circular genome rearrangement models
(p. 97)

17:00 Md Nurul Anwar (The University of Melbourne)
A multiscale mathematical model of Plasmodium vivax transmission
(p. 92)

17:30 Maia Nikolova Angelova (Deakin University)
Delay differential equations model of glucose- insulin dynamics: Towards a digital twin model
(p. 91)

19:00 John bailie John bailie (The University of Auckland)
Bifurcation analysis of a conceptual model for the Atlantic Meridional Overturning Circulation
(p. 95)

19:30 Kyle Jacob Stevens (The University of Newcastle)
More continuum modelling with the Lennard-Jones potential
(p. 97)

4. Computational Mathematics

14:30 Jerome Droniou (Monash University)
An arbitrary-order robust polygonal scheme for the Reissner-Mindlin plate problem
(p. 99)

15:00 Liam Yemm (Monash University)
An Extended Hybrid High-Order method for the Poisson problem with singular solutions
(p. 104)

16:00 Neil Kristofer Dizon (The University of Newcastle)
Quaternion-valued wavelets in colour image processing
(p. 99)

16:30 Frederick Fung (Australian National University)
On accurate numerical simulations of nonlinear dynamic shear ruptures on non-planar faults embedded in 3D elastic solids using upwind finite difference methods
(p. 100)

17:00 Chris Christopher Williams (None)
Dispersion relation preserving schemes
(p. 98)

17:30 Hailong Guo (The University of Melbourne)
Deep unfitted Nitsche method for elliptic interface problems
(p. 101)

6. Dynamical Systems and Ergodic Theory

14:30 Philipp Braun (Australian National University)
Stability of Dynamical Systems and Lyapunov-like Characterizations
(p. 108)

15:00 Leo Jiang (University of Toronto)
Configurations in trees of positive dimension
(p. 110)

16:00 Claudio Arancibia-Ibarra (Queensland University of Technology)
Non-Stationary Patterns in a three-component FitzHugh-Nagumo System
(p. 108)

16:30 Caroline Wormell (CNRS)
Linear response in higher dimensions and mixing of Cantor sets
(p. 112)

17:00 Peter Koltai (Freie Universiteit Berlin)
The birth and death of coherence: semi-material coherent sets
(p. **??**)

19:00 ()
(p. **??**)

19:30 ()
(p. **??**)

9. Geometry with Symmetries

14:30 Artem Pulemotov (The University of Queensland)
Mountain pass approach to the prescribed Ricci curvature problem
(p. 116)

15:00 Timothy Buttsworth (The University of Queensland)
SU(2)-invariant steady Ricci solitons on cohomogeneity one four-manifolds
(p. 114)

16:00 Kyle Broder (The Australian National University)
Recent developments in the curvature of Hermitian manifolds
(p. 114)

16:30 James Stanfield (None)
Positive Hermitian curvature flow on nilpotent and almost-abelian complex Lie groups
(p. 116)

17:00 Valentina-Mira Wheeler (University of Wollongong)
Curve diffusion and free elastic flows on parallel lines
(p. 117)

17:30 Haotian Wu (The University of Sydney)
A numerical stability analysis of mean curvature flow of noncompact hypersurfaces with Type-II curvature blowup
(p. 117)

10. Geometric and Harmonic Analysis

16:00 Glen Edward Wheeler (University of Wollongong)
On the entropy flow
(p. 120)

16:30 Hosea Wondo (The University of Sydney)
The Continuity Method on Kahler Manifolds
(p. 120)

17:00 Adam Sikora (Macquarie University)
Vertical and horizontal Square Functions on a Class of Non-Doubling Manifolds
(p. 119)

17:30 Ji Li (Macquarie University)
Singular value estimates of commutators of Calderon–Zygmund operators— recent progresses on stratified Lie groups

(p. 119)

13. Integrable systems and Mathematical Physics

14:30 ()
(p. ??)

16:00 David Pfefferlé (The University of Western Australia)
Relative helicity formulae in magnetostatics from cohomological methods
(p. 127)

16:30 David Perrella (The University of Western Australia)
Integrability of normal distributions: A Stefan-Sussmann theorem and neat foliations by manifolds with boundary
(p. 127)

17:00 Benjamin Morris (Australian National University)
Towards a factorised solution of the Yang-Baxter equation with $U_q(\mathfrak{sl}_n)$ symmetry
(p. 126)

17:30 Andrew Kels (International School for Advanced Studies (SISSA))
16 new Yang-Baxter maps
(p. 125)

14. Mathematics Education

16:00 Adam Piggott (Australian National University)
Engaging high-achievers through weekly authentic assessment tasks
(p. 130)

16:30 Julia Collins (Edith Cowan University)
Student and staff approaches to academic integrity in calculation-based assessments
(p. 128)

17:00 Antony Edwards (Swinburne University of Technology)
Evidence bases in Mathematics Education
(p. 129)

15. Number Theory and Algebraic Geometry

14:30 Igor Shparlinski (UNSW Sydney)
Pseudorandomness of Kloosterman and Salie Sums
(p. 135)

16:00 Matthew Paul Skerritt (RMIT University)
Computing Quadratic Integer Relations
(p. 136)

16:30 Shehzad Shabbirbhai Hathi (UNSW Canberra)
Oscillations in Mertens' product formula for number fields
(p. 134)

17:00 Ethan Simpson Lee (UNSW Canberra)
Explicit Estimates for the Residue of the Dedekind zeta-function
(p. 135)

17:30 Aleksander Simonic (University of New South Wales Canberra)
Effective conditional estimates for the argument of ζ on the critical line with applications
(p. 135)

19:00 Daniel Johnston (UNSW Canberra)
Improving bounds on prime counting functions
(p. 135)

16. Non-commutative Geometry and Operator Algebras

19:00 ()
(p. ??)

19:30 ()
(p. ??)

17. Optimisation

14:30 Matthew Tam (The University of Melbourne)
Can we do better than the product space?
(p. 144)

15:00 Lien Nguyen (RMIT University)
Fixed-Time Gradient Dynamics with Time-Varying Coefficients for Continuous-Time Optimization
(p. 142)

16:00 Alexander Kruger (Federation University Australia)
A Radius Theorem for Metric Subregularity
(p. 141)

16:30 Bethany Caldwell (University of South Australia)
Splitting and projection methods for control-constrained linear-quadratic optimal control problems
(p. 140)

17:00 Xuemei Liu (University of South Australia)
A Primal—Dual Penalty Algorithm for Optimal Control of the Double Integrator
(p. 142)

17:30 Andrew Craig Eberhard (RMIT University)
Monotone Operators and Closures Operations for convex sets in XX^*.
(p. 141)

18. Partial Differential Equations: From Theory to Applications

14:30 Yihong Du (University of New England)
Free Boundary Problems with a Source Term in n-Space Dimension
(p. 146)

16:00 Artem Pulemotov (The University of Queensland)
The prescribed cross curvature problem
(p. 148)

17:00 Giacomin Giovanni (The University of Western Australia)
The Fractional Malmheden Theorem
(p. 146)

19:00 Daniel Hauer (The University of Sydney)
The Dirichlet-to-Neumann operator associated with the 1-Laplacian and evolution problems
(p. 147)

19. Probability Theory and Stochastic Processes

14:30 Aihua Xia (The University of Melbourne)
Geometric sums, size biasing and zero biasing
(p. 155)

15:00 Illia Donhauzer (La Trobe University)
Asymptotics of running maxima for phi-subgaussian random double arrays
(p. 150)

16:00 Tiffany Y. Y. Lo (The University of Melbourne)
The expected degree distribution in transient duplication divergence models
(p. 152)

16:30 ZHIHAO QIAO (The University of Queensland)
Critical parameter configurations of polynomials of a random variable
(p. 154)

17:00 Anant Mathur (UNSW Sydney)
Variance Reduction for Large Matrix Computations
(p. 152)

17:30 Stephen Muirhead (The University of Melbourne)
Mean-field bounds for Poisson-Boolean percolation
(p. 153)

20. Representation Theory

14:30 Daniel Tubbenhauer (The University of Sydney)
Monoidal categories and cryptography
(p. 158)

15:00 Anthony Licata (Australian National University)
q-rational numbers and stability conditions on the A_2 quiver
(p. 157)

16:00 Travis Scrimshaw (Osaka City University)
K-Theoretic Schubert Calculus and Stochastic Processes
(p. 158)

16:30 Joshua Ciappara (The University of Sydney)
Hecke category actions via Smith–Treumann theory
(p. 156)

17:00 Gaston Burrull (The University of Sydney)
Unimodality of Bruhat intervals
(p. 156)

17:30 Ivo De Los Santos Vekemans (Australian National University)
Mackey functors as G-commutative monoids
(p. 158)

19:00 ()
(p. **??**)

19:30 ()
(p. **??**)

21. Topology

14:30 Alexander He (The University of Queensland)
Greedy retriangulation of 3-manifolds
(p. 160)

15:00 Emily Thompson (Monash University)
Twisting, ladder graphs and A-polynomials
(p. 162)

16:00 Amnon Neeman (Australian National University)
A counterexample to vanishing conjectures in negative K-theory
(p. 162)

Wed 8 December

Summary timetable

When	What
08:00–09:00	2 special session talks
08:00–08:30	7 special session talks
08:30–09:30	2 special session talks
08:30–09:00	7 special session talks
09:00–09:30	9 special session talks
09:30–10:30	**Plenary:** Riehl – From path induction to arrow induction and the dependent Yoneda lemma (p. 84)
10:30–11:00	Coffee break
11:00–12:00	**EDI Panel discussion**
12:00–13:00	Lunch
13:00–14:00	**Plenary:** Brent – Jonathan Borwein: Life and Legacy (p. 83)
14:00–15:00	5 special session talks
14:00–14:30	8 special session talks
14:30–15:00	8 special session talks
15:00–15:30	13 special session talks
15:30–16:00	Break
16:00–17:00	3 special session talks
16:00–16:30	10 special session talks
16:30–17:00	10 special session talks
17:00–18:00	**Plenary:** Matthews – My Journey as a Goori Mathematician (p. 84)
18:00–19:00	2 special session talks
18:00–18:30	5 special session talks
18:30–19:00	5 special session talks
19:00–20:00	3 special session talks
19:00–19:30	4 special session talks
19:30–20:00	4 special session talks

Non-plenary Sessions

2. Algebra

08:00 ()
(p. **??**)

08:30 Yudhistira Andersen Bunjamin (UNSW Sydney)
Isomorphisms and automorphisms of group divisible designs
(p. 86)

09:00 João Vitor Pinto e Silva (The University of Newcastle)
Matrices indexed by (possibly infinite) partially ordered sets
(p. 90)

16:00 David Harvey (University of New South Wales)
Fast multiplication: some unsolved problems
(p. 88)

18:00 Giacomo Tendas (Macquarie University)
On continuity of functors between locally presentable categories
(p. 90)

18:30 Su Yuan Chan (Deakin University)
Bounds on the Inducibility of Double Loop Graphs
(p. 86)

19:00 Riya Jose (Cochin University of Science and Technology)
Chain Bundles and Category of Chains
(p. 88)

19:30 Carmine Monetta (University of Salerno)
p-nilpotency criteria for some commutator subgroups of a finite group
(p. 89)

4. Computational Mathematics

08:00 Bishnu Lamichhane (The University of Newcastle)
A Simple Numerical Scheme for Reissner-Mindlin Plate Equations
(p. 101)

08:30 Jordan Shaw-Carmody (The University of Newcastle)
Local projection stabilisation of convection dominated problems using a biorthogonal system and adaptive finite element method
(p. 103)

09:00 Sean McGowan (The University of Adelaide)
Model-free prediction of noisy, chaotic systems
(p. 102)

14:00 Ian Sloan (University of New South Wales)
So you have shown that two function spaces are equivalent? Why does it matter? Who cares?
(p. 103)

14:30 Alexander Gilbert (University of New South Wales)
Density estimation using quasi-Monte Carlo methods with preintegration
(p. 100)

15:00 Abirami Srikumar (UNSW Sydney)
Approximating distribution functions for solutions to partial differential equations with random coefficients using quasi-Monte Carlo methods and preintegration
(p. 103)

16:00 Santiago Badia (Monash University)
Recent advances in unfitted finite element methods
(p. 98)

5. Cryptography, Coding Theory and Related Topics

08:00 Jeffrey Hoffstein (Brown University)
Public key cryptography and lattices with a ring structure
(p. 105)

09:00 Muhammad Nauman Khan (RMIT University)
Classical to Post-Quantum ABE-IBE Proxy Re-Encryption Scheme
(p. 105)

14:00 Youming Qiao (University of Technology Sydney)
Revisiting signature schemes based on isomorphism problems
(p. 106)

14:30 Muhammed Esgin (Monash University)
Math & Crypto: How CRT is Used to Solve Interesting Crypto Problems
(p. 104)

15:00 Robby McKilliam (Myriota)
Finding shortest and closest vectors in a lattice of Voronoi's first kind
(p. 106)

16:00 Travis Scrimshaw (Osaka City University)
Computational Problems from Combinatorics and Algebra
(p. 107)

16:30 Vladimir Shpilrain (City University of New York)

Redactable blockchains
(p. 107)

6. Dynamical Systems and Ergodic Theory

08:00 Hinke Osinga (The University of Auckland)
Phase resetting as a two-point boundary value problem
(p. 111)

08:30 Sean Gasiorek (The University of Sydney)
Linear Stability of Periodic Trajectories in Inverse Magnetic Billiards
(p. 109)

09:00 Mitch Curran (The University of Sydney)
Applying the Maslov index to the Nonlinear Schrodinger equation
(p. 109)

7. Education Afternoon

14:00 Erik Stern (Weber State University)
Do the Same, Do the Opposite: An Intro to the Physical-Conceptual Connection
(p. 112)

15:00 Cassandra Portelli (Hunter School of Performing Arts)
Spaced Learning
(p. 112)

16:00 Chris Tisdell (University of New South Wales)
Beyond the Compass: Geometric Constructions with Circle Templates
(p. 113)

16:30 Linda McIver (Australian Data Science Education Institute)
A Quick and Easy Introduction to Classroom Data Science
(p. 112)

9. Geometry with Symmetries

14:00 Peter Petersen (University of California Los Angeles)
New Curvature Conditions for the Bochner Technique
(p. 115)

15:00 Yuri Nikolayevsky (La Trobe University)
Einstein hypersurfaces in irreducible symmetric spaces
(p. 115)

16:00 Mat Langford (The University of Newcastle)
Symmetric and asymmetric ancient mean curvature flows
(p. 115)

16:30 Benjamin Blake McMillan (The University of Adelaide)
The secondary characteristic classes of singular foliations
(p. 115)

10. Geometric and Harmonic Analysis

18:00 Sanghyuk Lee (Seoul National University)
Maximal and regularity estimates for averages over curves
(p. 119)

18:30 Neal Bez (Saitama University)
Regularized inverse Brascamp-Lieb inequalities
(p. 117)

19:00 Jongchon Kim (City University of Hong Kong)
Geometric maximal functions associated with spheres
(p. 118)

19:30 Keith Rogers (Spanish National Research Council)
Improved bounds for the Kakeya maximal conjecture using semialgebraic geometry
(p. 119)

11. Harmonic Analysis and Hyperbolic PDEs

08:30 Leo Tzou (The University of Sydney)
Single Observer Tomography via Nonlinear Waves
(p. 123)

14:00 Yihong Du (University of New England)
Long-time dynamics of the Fisher-KPP nonlocal diffusion equation with free boundary
(p. 121)

15:00 Zijun Chen (Monash University)
Local well-posedness for the Zakharov system in dimension d=2, 3
(p. 121)

16:00 Antoine Gansemer (Australian National University)
Exact Egorov theorem
(p. 121)

16:30 Quoc Hung NGUYEN (Chinese Academy of Sciences)
Well-posedness of the Muskat and Peskin problems
(p. 122)

13. Integrable systems and Mathematical Physics

08:30 ()
(p. **??**)

14:00 Nalini Joshi (The University of Sydney)
Motion and monodromy
(p. 125)

14:30 Joshua Holroyd (The University of Sydney)
Asymptotic Analysis and Special Solutions of a Family of Painlevé-Like Equations
(p. 124)

15:00 Tomas Lasic Latimer (The University of Sydney)
Asymptotic behaviours of q-orthogonal polynomials from a q-Riemann Hilbert Problem
(p. 125)

16:00 Milena Radnovic (The University of Sydney)
Resonances of elliptical billiards
(p. 127)

16:30 Mitchell Ryan (The University of Queensland)
The Supersymmetric Box-Ball System
(p. 127)

18:00 Oleg Lisovyy (Université de Tours)
From Painlevé functions to Heun accessory parameters and back
(p. 126)

19:00 Marta Mazzocco (University of Birmingham)
Isomonodromic deformations: Confluence, Reduction & Quantisation
(p. **??**)

15. Number Theory and Algebraic Geometry

14:00 Dzmitry Badziahin (The University of Sydney)
Uniform rational approximation to a number and its consecutive powers
(p. 132)

15:00 Ayreena Bakhtawar (UNSW Sydney)
Continued fractions and Improvements to Dirichlet's theorem
(p. 132)

16:00 Timothy Trudgian (UNSW Canberra)
An apparent bias? Of course: fake mu's!
(p. 136)

16:30 Valeriia Starichkova (UNSW Canberra)

On explicit lower bounds for L-functions.
(p. 136)

18:00 Michaela Cully-Hugill (University of New South Wales Canberra)
Primes between powers
(p. 133)

18:30 Matteo Bordignon (University of New South Wales Canberra)
An explicit version of Chen's theorem
(p. 133)

19:00 Forrest James Francis (Australian Defence Force Academy)
Explicit Estimates for Dirichlet L-functions
(p. 133)

19:30 Hayder Hashim (Kufa University, Faculty of Computer Science and Mathematics)
Curious properties of generalized Lucas numbers
(p. 133)

16. Non-commutative Geometry and Operator Algebras

14:00 Mathai Varghese (The University of Adelaide)
Witten Genus and Elliptic genera for proper actions
(p. 139)

15:00 Lukas Anagnostou (The University of Melbourne)
Characterising Supermanifolds
(p. 137)

16:00 Alan Stoneham (UNSW Sydney)
A generalisation of the spectral theorem for normal operators
(p. 139)

16:30 Ada Masters (None)
Commutativity and geometry
(p. 137)

18:00 Angus Alexander (University of Wollongong)
Levinson's Theorem as an index pairing
(p. 137)

18:30 Rafael Rafael Pereira Lima (Victoria University of Wellington)
AFE property for the Deaconu-Renault groupoid
(p. 138)

19:00 Joel Zimmerman (University of Wollongong)
Fell Bundle Models for C-algebras.*
(p. 139)

19:30 Nicholas Seaton (University of Wollongong)
The Brauer group for Fell algebras.
(p. 138)

17. Optimisation

08:00 ()
(p. **??**)

08:30 Thi Hoa Bui (Curtin University)
Solving nonlinear binary optimisation with cutting planes
(p. 140)

09:00 Sona Taheri (Royal Melbourne Institute of Technology)
Nonsmooth DC optimization-based piecewise linear L1-regression
(p. 144)

14:00 ()
(p. **??**)

14:30 Vinesha Peiris (Swinburne University of Technology)
Rational activation functions in neural networks with uniform norm based loss functions and its application in classification.

(p. 142)

15:00 Ponpot Jartnillaphand (Curtin University)
Logic-based Benders' Decomposition for Crew Scheduling in maintenance operation
(p. 141)

16:00 Julien Ugon (Deakin University)
Flexible rational approximation for matrix functions
(p. 145)

16:30 Daniel Uteda (The University of Melbourne)
The Bregman Golden Ratio Algorithm for Min-Max Optimisation
(p. 145)

18:00 Lindon Roberts (Australian National University)
Derivative-Free Optimization with Convex Constraints
(p. 143)

18:30 James Saunderson (Monash University)
A convex form that is not a sum of squares
(p. 143)

19:00 Radu Ioan Bot (University of Vienna)
Continuous time approaches to structured convex minimization problems
(p. 140)

18. Partial Differential Equations: From Theory to Applications

08:00 Valentina-Mira Wheeler (University of Wollongong)
On the Chen flow
(p. 149)

09:00 ()
(p. **??**)

14:00 Jack Thompson (The University of Western Australia)
On an overdetermined problem involving the fractional Laplacian
(p. 148)

14:30 Jonathan Mui (The University of Sydney)
Asymptotic behaviour of biharmonic heat equations on unbounded domains
(p. 147)

15:00 Timothy Allen Collier (The University of Sydney)
A doubly nonlinear evolution problem involving the fractional p-Laplacian
(p. 146)

16:00 Florica Corina Cirstea (The University of Sydney)
Isolated singularities for nonlinear elliptic equations with a gradient-dependent nonlinearity
(p. 145)

18:00 Glen Edward Wheeler (University of Wollongong)
On the p-elastic flow
(p. 149)

19:00 ()
(p. **??**)

19. Probability Theory and Stochastic Processes

14:00 Qihe Tang (University of New South Wales)
Pricing Defaultable Bonds and Credit Derivatives in the Presence of Shock Risk and Unpredictable Recovery
(p. 155)

14:30 Duy-Minh Dang (University of Queensland)
On the distribution of terminal wealth under dynamic mean-variance optimal investment strategies
(p. 150)

15:00 Robert Cantwell (University of New South Wales)

Towards a self-contained theory for stochastics in the complex plane
(p. 149)

16:00 Vincent Liang (The University of Melbourne)
On Markov chain approximations for computing boundary crossing probabilities of diffusion processes
(p. 151)

16:30 Ross McVinish (The University of Queensland)
Dominating stochastic patch occupancy models by independent patches
(p. 152)

20. Representation Theory

08:00 Ian Le (Australian National University)
Cluster algebras and mirror symmetry for flag varieties
(p. 157)

08:30 Marijana Butorac (University of Rijeka)
Principal subspaces of standard modules of affine Lie algebra of type $G_2^{(1)}$
(p. 156)

09:00 David Ridout (The University of Melbourne)
A Kazhdan–Lusztig correspondence for a vertex algebra associated to $\mathfrak{sl}_3$
(p. 158)

14:00 GyeongHyeon Nam (The University of Queensland)
Arithmetic geometry of representation varieties with regular monodromy
(p. 157)

14:30 Nick Bridger (University of Queensland)
Arithmetic geometry of characters stacks and their E-polynomials
(p. 156)

15:00 Martin Gossow (The University of Sydney)
Acting by the Long Cycle on the Kazhdan-Lusztig Basis
(p. 157)

21. Topology

08:00 Ellena Moskovsky (Monash University)
Fully simple maps and topological recursion
(p. 161)

08:30 Jack Brand (Australian Mathematical Sciences Institute)
Diagrams of Legendrian Knots In Closed Contact Manifolds
(p. 159)

09:00 Roland van der Veen (University of Groningen)
Where do quantum invariants come from?
(p. 162)

14:00 Thiago de Paiva Souza (Monash University)
Hyperbolic knots given by positive braids with at least two full twists
(p. 160)

14:30 Zsuzsanna Dancso (The University of Sydney)
Welded tangles and the Kashiwara-Vergne groups
(p. 160)

15:00 Tamara Hogan (The University of Melbourne)
Symmetries of 3D and 4D expansions
(p. 161)

16:00 Asilata Bapat (Australian National University)
Expansive rigid motions and a piecewise-linear sphere
(p. 159)

16:30 Daniel Mathews (Monash University)
A symplectic basis for 3-manifold triangulations
(p. 161)

22. Visualisation and Mathematical Art

08:00 Karen Amanda Harris (University of the Arts London)
Creating Non-Digital Maths Art: decisions, discipline and dizzying possibilities
(p. 164)

08:30 Michael Assis (The University of Melbourne)
Functional origami lampshades
(p. 163)

09:00 Bethany Caldwell (University of South Australia)
Visualisations of a generalised Newton method
(p. 163)

Thu 9 December

■ Summary timetable

When	What
08:00–09:00	Keynote
08:00–08:30	6 special session talks
08:30–09:30	2 special session talks
08:30–09:00	6 special session talks
09:00–09:30	7 special session talks
09:30–10:30	**Plenary:** Scott – Singularities of Space-Time (p. 84)
10:30–11:00	Coffee Break
11:00–12:00	**Plenary:** Flegg – Data-driven mathematical models for malaria response (p. 83)
12:00–13:00	Lunch
13:00–14:00	Keynote
13:00–13:30	11 special session talks
13:30–14:30	Special session talk
13:30–14:00	11 special session talks
14:00–14:30	12 special session talks
14:30–15:00	12 special session talks
15:00–15:30	11 special session talks
15:30–16:00	Break
16:00–17:00	**Plenary:** – (p. **??**)
18:30–	Dinner

■ Non-plenary Sessions

3. Applied and Industrial Mathematics

08:00 Edward Bissaker (The University of Newcastle)
An Informed Simulated Annealing method for coke reconstruction.
(p. 93)

08:30 Matthew Berry (University of Wollongong)
Understanding the impact of Hotspots on the self-heating behaviour of Industrial stockpiles
(p. 93)

09:00 Mona Bahri (UNSW Canberra)
Time Series Forecasting Using Smoothing Ensemble Empirical Mode Decomposition and Machine Learning Techniques
(p. 92)

13:00 Diane Donovan (The University of Queensland)
Advanced Mathematical Modelling For Improved Learning Cycle Assessment Natural Gas Wells' Performance
(p. 93)

13:30 Thiansiri Luangwilai (Navaminda Kasatriyadhiraj Royal Thai Air Force Academy)
Understanding the factors affecting the self-heating process of compost piles – two-dimensional analysis
(p. 95)

14:00 Lucy Ham (The University of Melbourne)
Unravelling the correlation structure of noise in molecular pathways
(p. 94)

14:30 Venta Terauds (University of Tasmania)
Genome algebras in action
(p. 97)

15:00 ()
(p. **??**)

4. Computational Mathematics

13:00 William McLean (University of New South Wales)
Superconvergence effects for discontinuous Galerkin time stepping
(p. 102)

13:30 Geordie Drummond McBain (None)
Compressed vector Prony analysis for supercritical Hopf bifurcations in computational fluid dynamics
(p. 101)

14:00 Vivien Challis (Queensland University of Technology)
Multi-objective structural optimisation of piezoelectric materials
(p. 98)

14:30 Kenneth Duru (The Australian National University)
Upwind Summation By Parts Finite Difference Methods for Large Scale Elastic Wave Simulations In Complex Geometries
(p. 100)

15:00 Rob Corless (University of Western Ontario)
Hybrid symbolic-numeric computation for Bohemian matrices
(p. 99)

5. Cryptography, Coding Theory and Related Topics

08:00 Swastik Kopparty (University of Toronto)
Proving Proximity to Polynomials
(p. 105)

08:30 Felipe Voloch (University of Canterbury)
Locally recoverable codes and algebraic surfaces
(p. 108)

09:00 Son Hoang Dau (RMIT University)
On a Tree Coloring Problem and Its Application in Private Data Retrieval from a Merkle Tree
(p. 104)

13:00 Geetika Verma (RMIT University)
Swarm Randon Number Generator for use in secret sharing
(p. 107)

13:30 Matthew Paul Skerritt (RMIT University)
Threshold Ed25519 Digital Signatures
(p. 107)

14:00 Anthony Overmars (None)
DRS Factorization Method
(p. 106)

6. Dynamical Systems and Ergodic Theory

08:00 Bernd Krauskopf (University of Auckland)
The geometry of a blender: the case of spaghetti in a can
(p. 110)

08:30 Kamil Bulinski (The University of Sydney)
Reconstructing a minimal topological dynamical system from a set of return times
(p. 109)

09:00 Eric William Hester (University of California Los Angeles)
On the stability of isothermal shocks in black hole accretion disks
(p. 110)

13:00 Carlo Laing (Massey University)
Periodic solutions of a theta neuron subject to delayed self-feedback
(p. 111)

13:30 Alexander Fish (The University of Sydney)
Sets of transfer times with small densities
(p. 109)

14:00 Cecilia Gonzalez-Tokman (The University of Queensland)
Quenched results for random open and closed dynamical systems
(p. 110)

14:30 Andy Hammerlindl (Monash University)
Ergodicity and accessibility in dimension 3
(p. 110)

15:00 John Roberts (University of New South Wales)
A combinatorial model for the dynamics of birational maps over finite fields
(p. 111)

8. Equity, Diversity and Inclusivity in Mathematics

14:30 Joanne Hall (Royal Melbourne Institute of Technology)
Gender differences in the skills sought when recruiting for graduate roles
(p. 114)

15:00 Yudhistira Andersen Bunjamin (UNSW Sydney)
Designing mathematics outreach workshops for operational versatility
(p. 113)

9. Geometry with Symmetries

13:00 Guofang Wei (University of California, Santa Barbara)
Examples of Ricci limit spaces with non-integer Hausdorff dimension
(p. 116)

14:00 Jonathan Julian Zhu (Australian National University)
Min-max theory for capillary surfaces
(p. 117)

14:30 Gerd Schmalz (University of New England)
CR embeddings of CR manifolds with complex infinitesimal symmetries
(p. 116)

15:00 Emma Carberry (The University of Sydney)
Blowing up Sequences of Constant Mean Curvature Tori in Euclidean 3-Space to Yield Minimal Surfaces
(p. 114)

10. Geometric and Harmonic Analysis

13:30 ()
(p. **??**)

14:00 Yong Wei (University of Science and Technology of China)
Weighted geometric inequalities for hypersurfaces in space forms
(p. 120)

14:30 Zhou Zhang (The University of Sydney)
Stability of Volume Preserving Mean Curvature Flow in Hyperbolic Space
(p. 120)

15:00 Man-Chun Lee (The Chinese University of Hong Kong)
continuous metric and scalar curvature
(p. 118)

12. Indiginising University Mathematics

08:30 Michael Donovan (Macquarie University)
Panel: Indigenous Thinkers Talking Maths
(p. **??**)

13:00 Tyson Yunkaporta (Deakin University)
TBA
(p. **??**)

13:30 Erik Stern (Weber State University)
Embodied Learning: Connecting Movement and Mathematics
(p. **??**)

14:00 Maureen Edwards (University of Wollongong)
Jindaola
(p. 123)

13. Integrable systems and Mathematical Physics

08:00 Ian Marquette (University of Queensland)
Painlevé VI, rational potentials and cubic algebras
(p. 126)

08:30 Pieter Roffelsen (The University of Sydney)
On the monodromy surface of q-Painlevé VI
(p. **??**)

09:00 Vishnu Mangalath (None)
Singularities of Whitham Deformations
(p. 126)

13:00 Harini Desiraju (MSRI/UC Berkeley)
Painlevé equations, Fredholm determinants and Conformal blocks
(p. **??**)

13:30 Sean Gasiorek (The University of Sydney)
Minkowski Billiards on the Hyperboloid of One Sheet
(p. 124)

14:00 Chris Bourne (Tohoku University)
Symmetry protected topological (SPT) phases of infinite fermion chains
(p. 124)

14:30 Norman Do (Monash University)
The topological vertex and the infinite wedge
(p. 124)

15:00 Yury Stepanyants (University of Southern Queensland)
Lump interactions with plane solitons
(p. 128)

16. Non-commutative Geometry and Operator Algebras

13:00 Chris Bourne (Tohoku University)
Locally equivalent quasifree states and the coarse index
(p. 137)

13:30 Alexander Mundey (University of Wollongong)
Perfecting noncommutative topology
(p. 137)

14:00 Abraham Ng (University of Wollongong)
Stably finite extensions of rank-2 graph C-algebras*
(p. 138)

14:30 Aidan Sims (University of Wollongong)
Graded KK-groups for graph algebras
(p. 138)

15:00 ()
(p. **??**)

17. Optimisation

08:00 Levent Tuncel (University of Waterloo)
Mathematical Foundations of Primal-Dual Algorithms for Convex Optimisation
(p. 144)

09:00 Hui Ouyang (University of British Columbia, Okanagan)
Convergence of generalized proximal point algorithms
(p. 142)

13:00 Nadia Sukhorukova (Swinburne University of Technology)
Approximations in the form of quasilinear functions
(p. 143)

13:30 Erchuan Zhang (Edith Cowan University)
Finding geodesics joining given points
(p. 145)

14:00 Adil Bagirov (Federation University Australia)
An augmented subgradient method for nonsmooth DC optimization
(p. 139)

14:30 Fred Roosta (University of Queensland)
Invexifying Regularization of Non-Linear Least-Squares Problems
(p. 143)

15:00 Scott Boivin Lindstrom (Curtin University)
A primal/dual computable approach to improving spiraling algorithms, based on minimizing spherical surrogates for Lyapunov functions
(p. 141)

18. Partial Differential Equations: From Theory to Applications

08:30 Jiakun Liu (University of Wollongong)
Recent regularity theory of optimal transport and applications
(p. 147)

13:00 Maria Farcaseanu (The University of Sydney)
Classification of singular solutions to nonlinear elliptic equations with a gradient term
(p. 146)

13:30 Xu-Jia Wang (Australian National University)
Regularity of free boundary for the Monge-Ampere obstacle problem
(p. 148)

14:30 Michael Meylan (The University of Newcastle)
Calculating Tsunami Waves using Complex Analysis
(p. 147)

19. Probability Theory and Stochastic Processes

13:00 Xi Geng (The University of Melbourne)
Precise Local Estimates for Hypoelliptic Differential Equations driven by Fractional Brownian Motion
(p. 151)

13:30 Andriy Olenko (La Trobe University)
Fractional SPDE for Random Tangent Fields on the Sphere
(p. 153)

14:00 Chunxi Jiao (The University of Sydney)
Solution of a stochastic Landau-Lifshitz-Slonczewski equation
(p. 151)

14:30 Robert Charles Griffiths (Monash University)
A class of non-reversible hypercube long-range random walks and Bernoulli autoregression
(p. 151)

15:00 Sarat Babu Moka (Macquarie University)
Graph Coloring via Partial Rejection Sampling
(p. 153)

20. Representation Theory

08:00 ()
(p. **??**)

08:30 ()
(p. **??**)

09:00 ()
(p. **??**)

21. Topology

08:00 Sophie Ham (Monash University)
TBA
(p. 160)

08:30 ()
(p. **??**)

09:00 Jonathan Spreer (The University of Sydney)
Normal surfaces and the complexity of 3-manifolds
(p. 162)

13:00 ()
(p. **??**)

13:30 ()
(p. **??**)

14:00 Diarmuid Crowley (The University of Melbourne)
Surface knots and bisections of the 4-sphere
(p. 159)

14:30 José Ayala Hoffmann (The University of Melbourne)
Gordian unlinks
(p. 159)

15:00 Martin Helmer (Australian National University)
Conormal Spaces and Whitney Stratifications
(p. 161)

Fri 10 December

Summary timetable

When	What
08:00–08:30	3 special session talks
08:30–09:00	4 special session talks
09:00–10:00	**Plenary:** Serra – Fractional minimal surfaces: an invitation for the skeptics (and the convinced) (p. 85)
10:00–10:30	3 special session talks
10:30–11:00	Coffee Break
11:00–12:00	**Plenary:** Araujo – Universal robustness-promoting structures in biochemical reaction networks (p. 83)
12:00–13:00	Lunch
13:00–14:00	3 special session talks
13:00–13:30	5 special session talks
13:30–14:00	5 special session talks
14:00–14:30	8 special session talks
14:30–15:00	7 special session talks
15:00–15:30	7 special session talks
15:30–16:00	Break
16:00–16:30	6 special session talks
16:30–17:00	6 special session talks
17:00–17:30	5 special session talks
17:30–18:00	5 special session talks

Non-plenary Sessions

2. Algebra

08:00 Heiko Dietrich (Monash University)
On a duality for codes over non-abelian groups
(p. 86)

08:30 Intan Muchtadi-Alamsyah (Institut Teknologi Bandung (ITB))
On Orthogonal Theta-Circulant MDS Matrices
(p. 89)

13:00 Marcy Robertson (The University of Melbourne)
Automorphisms of seemed surfaces, modular operads and Galois actions
(p. 90)

14:00 James East (Western Sydney University)
Congruences of twisted partition monoids
(p. 87)

14:30 Marcel Jackson (La Trobe University)
Presenting the Demon
(p. 88)

15:00 Adam Piggott (Australian National University)
Groups presented by length-reducing rewriting systems
(p. 89)

16:00 Michal Ferov (The University of Newcastle)
Automorphism groups of Cayley graphs of Coxeter groups: when are they discrete?
(p. 87)

16:30 Murray Elder (University of Technology Sydney)
Equations in hyperbolic groups
(p. 87)

17:00 Mihai-Silviu Lazorec ("Alexandru Ioan Cuza" University of Iasi)
Minimum/Maximum values of the number of cyclic subgroups of a finite p-group
(p. 89)

17:30 ()
(p. **??**)

3. Applied and Industrial Mathematics

13:00 Philip Broadbridge (La Trobe University)
Conditionally integrable reaction-diffusion systems: Lotka-Volterra Type Predator-Prey
(p. 93)

14:00 Luke Bennetts (The University of Adelaide)
Rayleigh–Bloch waves above the cut-off
(p. 92)

14:30 Vassili Kitsios (CSIRO)
Data driven stochastic parameterisation of the subgrid interactions between eddies, climate and topography in quasi-geostrophic simulations of the Antarctic Circumpolar Current
(p. 95)

15:00 Mark Nelson (University of Wollongong)
Time of death: linking differential equations and linear regression
(p. 96)

16:00 ()
(p. **??**)

16:30 ()
(p. **??**)

17:00 ()
(p. **??**)

17:30 ()
(p. **??**)

4. Computational Mathematics

13:00 Tareq Alodat (University of New South Wales)
Limit theorems for filtered long-range dependent random fields
(p. 97)

13:30 Michael Assis (The University of Melbourne)
An origami Universal Turing machine
(p. 98)

14:00 Quoc Thong Le Gia (University of New South Wales)
Solving partial differential equations on spheres using neural networks
(p. 101)

10. Geometric and Harmonic Analysis

16:00 Enrico Valdinoci (The University of Western Australia)
Long-range phase coexistence models and the nonlocal Allen-Cahn equation
(p. 120)

16:30 Serena Dipierro (The University of Western Australia)
The stickiness property of nonlocal minimal surfaces
(p. 117)

17:00 Daniel Hauer (The University of Sydney)
Functional Calculus via the extension technique: a first hitting time approach
(p. 118)

17:30 Jeffrey Hogan (The University of Newcastle)
Clifford translation and bandpass bases
(p. 118)

11. Harmonic Analysis and Hyperbolic PDEs

08:00 ()
(p. **??**)

08:30 ()
(p. **??**)

10:00 Arunmaran Mahenthiram (University of South Australia)
The harmonic-measure distribution functions of multiply connected regions
(p. 122)

13:00 xiao xiong (Harbin Institute of Technology)
Schatten properties of quantum derivatives on quantum tori
(p. 123)

13:30 Chun-Yen Shen (National Taiwan University)
Mattila-Sjolin distance problem for product sets
(p. 123)

14:00 Himani Sharma (The Australian National University)
Pseudodifferential calculi using Weyl pairs on L^p
(p. 122)

14:30 Hamed Baghal Ghaffari (The University of Newcastle)
New Properties of Clifford Prolate Spheroidal Wave Functions (CPSWFs)
(p. 121)

15:00 ()
(p. **??**)

12. Indiginising University Mathematics

08:30 Michael Donovan (Macquarie University)
Growth of a Community around "Indigenising University Mathematics"
(p. **??**)

14. Mathematics Education

13:00 David Yost (Federation University Australia)
Contrarian calculus
(p. 132)

13:30 Zsuzsanna Dancso (The University of Sydney)
Online engagement in advanced 2nd year mathematics
(p. 128)

14:00 Attila Egri-Nagy (Akita International University)
Flat Curriculum with Self-Contained Micro Topics
(p. 129)

14:30 Frank Valckenborgh (Macquarie University)
Reigniting mathematical and statistical thinking for final year science students
(p. 131)

15:00 George Papadopoulos (The University of Sydney)
Student Perspectives on Summer School versus term-time for Undergraduate Mathematics
(p. 130)

16:00 Leesa Sidhu (University of New South Wales Canberra)
Applying the "Care Factor" in the Maths and Stats Classroom
(p. 130)

16:30 Ava Greenwood (The University of Queensland)
Perspectives on partnership: exploring feedback opportunities for mathematics tutors through student-staff partnership
(p. 129)

17:00 Deborah Jackson (La Trobe University)
Looking for answers
(p. 130)

17:30 Chris Tisdell (University of New South Wales)
AustMS Accreditation of Mathematics Degrees and Programs
(p. 131)

15. Number Theory and Algebraic Geometry

13:00 Kevin Fergusson (Bond University)
Partitions into k-th Powers
(p. 133)

13:30 Randell Heyman (University of New South Wales)
Primes in floor function sets and sequences
(p. 134)

14:00 Lukas Zobernig (The University of Auckland)
Genus 2 Curves in Small Characteristic
(p. 136)

14:30 Alina Ostafe (University of New South Wales)
On a Problem of Lang for Matrix Polynomials
(p. 135)

15:00 ()
(p. **??**)

17. Optimisation

10:00 ()
(p. **??**)

19. Probability Theory and Stochastic Processes

13:00 Nathan Ross (The University of Melbourne)
Gaussian process approximation using Stein's method, with applications to queues
(p. 154)

13:30 ()
(p. **??**)

14:00 Greg Markowsky (Monash University)
On the probability of fast exits and long stays of a planar Brownian motion in simply connected domains
(p. 152)

14:30 Budhi Surya (Victoria University of Wellington)
Maximum likelihood estimation for a general mixture of Markov jump processes
(p. 154)

15:00 Eric C.K. Cheung (UNSW Sydney)
A bivariate Laguerre expansions approach for joint ruin probabilities in a two-dimensional insurance risk process
(p. 150)

16:00 Kostya Borovkov (The University of Melbourne)
Parisian ruin with random deficit-dependent delays for spectrally negative Lévy processes
(p. 149)

16:30 jae kyung woo (University of New South Wales)
Multitype branching process with nonhomogeneous Poisson and contagious Poisson immigration
(p. 155)

17:00 Libo Li (University of New South Wales)
Numerical schemes for jump-extended Constant-Elasticity-of-Variance (CEV) process
(p. 151)

17:30 ()
(p. **??**)

22. Visualisation and Mathematical Art

08:00 Sean Gardiner (UNSW Sydney)
Visual design of an outreach workshop based on bijections
(p. 163)

08:30 Asha Rao (Royal Melbourne Institute of Technology)
Connecting sewing to higher mathematics
(p. 165)

10:00 Matthew Paul Skerritt (RMIT University)
Awards in the CARMA Maths/Art Poster Competition
(p. **??**)

13:00 Daniel Francis Mansfield (University of New South Wales)
The geometry of rectangles in ancient Mesopotamia
(p. 164)

14:00 Katherine Seaton (La Trobe University)
Stitching the wallpaper groups
(p. 165)

14:30 Jo-ann Larkins (Federation University Australia)
Encoding language in mosaic knitting
(p. 164)

15:00 James East (Western Sydney University)
That's not a proof, it's a picture!
(p. 163)

16:00 Katherine Seaton (La Trobe University)
Discussion of Mathematical Art at future AustMS meetings
(p. 165)

16:30 ()
(p. **??**)

List of Registrants

Current as of Wed 1 Dec 2021

Assoc Prof Paul Abbott	The University of Western Australia
Dr Rizal Afgani	Institut Teknologi Bandung (ITB)
Mr Seamus Albion (S)	University of Vienna
Mr Angus Alexander (S)	University of Wollongong
Miss Alhanouf Almutairi (S)	The University of Queensland
Dr Tareq Alodat	University of New South Wales
Dr Xin An (S)	UNSW Sydney
Mr Lukas Anagnostou (S)	The University of Melbourne
Prof Maia Nikolova Angelova	Deakin University
Mr Md Nurul Anwar (S)	The University of Melbourne
Dr Claudio Arancibia-Ibarra (S)	Queensland University of Technology
Dr Robyn Patrice Araujo	Queensland University of Technology
Mr Arthur Arthur van der Merwe (S)	University of New England
Dr Michael Assis	The University of Melbourne
Dr Jason Atnip	University of New South Wales
Dr José Ayala Hoffmann	The University of Melbourne
Prof Santiago Badia	Monash University
Assoc Prof Dzmitry Badziahin	The University of Sydney
Mr Hamed Baghal Ghaffari (S)	The University of Newcastle
Prof Adil Bagirov	Federation University Australia
Mx Mona Bahri (S)	UNSW Canberra
Dr Ayreena Bakhtawar	UNSW Sydney
Assoc Prof Rowena Ball	The Australian National University
Dr John Banks	The University of Melbourne
Mr Tim Banova (S)	The University of Melbourne
Dr Asilata Bapat	Australian National University
Dr Luke Bennetts	The University of Adelaide
Mr Matthew Berry (S)	University of Wollongong
Prof Neal Bez	Saitama University
Mr Sebastian Bischof	Justus Liebig Universität Gießen
Mr Edward Bissaker (S)	The University of Newcastle
Dr Bea Bleile	University of New England
Mr Corentin Bodart (S)	University of Geneva
Mr Matteo Bordignon (S)	University of New South Wales Canberra
Prof Kostya Borovkov	The University of Melbourne
Prof Radu Ioan Bot	University of Vienna
Mr Chris Bourne	Tohoku University
Ms Elizabeth Bradford (S)	University of South Australia
Mr Jack Brand (S)	Australian Mathematical Sciences Institute
Dr Philipp Braun	Australian National University
Prof Richard P Brent	Australian National University
Prof Florian Breuer	The University of Newcastle
Mr Nick Bridger (S)	University of Queensland
Prof Philip Broadbridge	La Trobe University
Mr Kyle Broder (S)	The Australian National University
Mr Jason Brown (S)	Macquarie University
Mr James Bubear (S)	RMIT University
Dr Anh Bui	Macquarie University
Dr Thi Hoa Bui	Curtin University

Dr Kamil Bulinski	The University of Sydney
Mr Yudhistira Andersen Bunjamin (S)	UNSW Sydney
Prof Regina S. Burachik	University of South Australia
Mr Gaston Burrull (S)	The University of Sydney
Dr Marijana Butorac	University of Rijeka
Dr Timothy Buttsworth	The University of Queensland
Ms Dana C'Julio (S)	The University of Auckland
Miss Julianne Cai (S)	The University of Queensland
Miss Bethany Caldwell (S)	University of South Australia
Mr Robert Cantwell (S)	University of New South Wales
Dr Emma Carberry	The University of Sydney
Mr Max Carter (S)	The University of Newcastle
Dr Vivien Challis	Queensland University of Technology
Miss Su Yuan Chan (S)	Deakin University
Dr Anupam Chaudhuri (S)	Monash University
Mr Benjamin Cheah (S)	Monash University
Miss Yuhui Chen (S)	Australian National University
Dr Zijun Chen (S)	Monash University
Ms Eve Cheng (S)	The Australian National University
Assoc Prof Eric C.K. Cheung	UNSW Sydney
Dr Renu Choudhary	Auckland University of Technology
Mr Chris Christopher Williams (S)	None
Mr Joshua Ciappara (S)	The University of Sydney
Assoc Prof Florica Corina Cirstea	The University of Sydney
Mr Bryce Clarke (S)	Macquarie University
Dr Nathan Clisby	Swinburne University of Technology
Dr Andrea Collevecchio	Monash University
Mr Timothy Allen Collier (S)	The University of Sydney
Dr Julia Collins	Edith Cowan University
Dr Diana Combe	University of New South Wales
Dr Matthew Conder	The University of Auckland
Dr Michael Coons	University of Bielefeld
Dr Robert Cope	Australian National University
Prof Rob Corless	University of Western Ontario
Ms Jaklyn Crilly (S)	Australian National University
Miss Gemma Crowe (S)	Heriot-Watt University
Assoc Prof Diarmuid Crowley	The University of Melbourne
Ms Michaela Cully-Hugill (S)	University of New South Wales Canberra
Mr Mitch Curran (S)	The University of Sydney
Dr Zsuzsanna Dancso	The University of Sydney
Dr Duy-Minh Dang	University of Queensland
Dr Sarah Dart	Queensland University of Technology
Dr Son Hoang Dau	RMIT University
Mr Thiago de Paiva Souza (S)	Monash University
Ms Ajani De Vas Gunasekara (S)	Monash University
Dr Owen Dearricott	La Trobe University
Dr Dmitry Demskoi	Charles Sturt University
Mr Stephen Deng (S)	None
Dr Anand Rajendra Deopurkar	Australian National University
Dr Harini Desiraju	MSRI/UC Berkeley
Dr Harini Desiraju	MSRI/UC Berkeley
Mr Nicola Di Vittorio (S)	Macquarie University
Dr Reinier Diaz Millan	Deakin University
Assoc Prof Heiko Dietrich	Monash University
Prof Serena Dipierro	The University of Western Australia
Mr Neil Kristofer Dizon (S)	The University of Newcastle
Assoc Prof Norman Do	Monash University
Mr Illia Donhauzer (S)	La Trobe University
Prof Diane Donovan	The University of Queensland

Dr Michael Donovan	Macquarie University
Prof Jerome Droniou	Monash University
Prof Yihong Du	University of New England
Ms Michelle Du Toit	None
Dr Kenneth Duru	The Australian National University
Dr James East	Western Sydney University
Prof Andrew Craig Eberhard	RMIT University
Dr Antony Edwards	Swinburne University of Technology
Dr Maureen Edwards	University of Wollongong
Dr Attila Egri-Nagy	Akita International University
Prof Murray Elder	University of Technology Sydney
Dr Muhammed Esgin	Monash University
Dr Maria Farcaseanu	The University of Sydney
Dr Kevin Fergusson	Bond University
Dr Michal Ferov	The University of Newcastle
Prof Lilia Ferrario	Australian National University
Prof Jerzy Filar	The University of Queensland
Assoc Prof Alexander Fish	The University of Sydney
Assoc Prof Jennifer Flegg	The University of Melbourne
Dr Chi-Kwong Fok	The University of Auckland
Mr Forrest James Francis (S)	Australian Defence Force Academy
Mr Saul Freedman (S)	University of St Andrews
Prof Gary Froyland	University of New South Wales
Mr Frederick Fung (S)	Australian National University
Ms Evelyn Dumag Gabinete (S)	The University of Sydney
Dr Masoud Ganji	University of New England
Mr Antoine Gansemer (S)	Australian National University
Dr Giles Gardam	University of Muenster
Ms Grace Garden (S)	The University of Sydney
Dr Sean Gardiner	UNSW Sydney
Assoc Prof Timothy Garoni	Monash University
Dr Sean Gasiorek	The University of Sydney
Dr Xi Geng	The University of Melbourne
Mr Giovanni Giacomin (S)	The University of Western Australia
Ms Katrina Gibbins (S)	None
Dr Alexander Gilbert	University of New South Wales
Mr Giacomin Giovanni (S)	The University of Western Australia
Dr Stephen Glasby	The University of Western Australia
Mr Daniel Glasson (S)	RMIT University
Miss Raquel Gonzalez-Farina (S)	The University of Oxford
Dr Raquel Gonzalez-Farina	None
Assoc Prof Cecilia Gonzalez-Tokman	The University of Queensland
Mr Roman Gorazd (S)	The University of Newcastle
Mx Martin Gossow (S)	The University of Sydney
Prof Catherine Greenhill	University of New South Wales
Dr Ava Greenwood	The University of Queensland
Prof Robert Charles Griffiths	Monash University
Dr Hailong Guo	The University of Melbourne
Mr Zihua Guo	Monash University
Dr Joanne Hall	Royal Melbourne Institute of Technology
Dr Lucy Ham	The University of Melbourne
Ms Sophie Ham (S)	Monash University
Dr Andy Hammerlindl	Monash University
Mr Jayden Hammet (S)	The University of Melbourne
Miss Ming Hao (S)	None
Miss Karen Amanda Harris	University of the Arts London
Ms Lucinda Harrison (S)	The University of Melbourne
Assoc Prof David Harvey	University of New South Wales

Mr Hayder Hashim	Kufa University, Faculty of Computer Science and Mathematics
Mr Shehzad Shabbirbhai Hathi (S)	UNSW Canberra
Dr Daniel Hauer	The University of Sydney
Dr Daniel Thomas Hayes	Swinburne University of Technology
Mr Alexander He (S)	The University of Queensland
Dr Martin Helmer	Australian National University
Prof Anthony Henderson	The University of Sydney
Dr Eric William Hester	University of California Los Angeles
Dr Randell Heyman	University of New South Wales
Prof Jeffrey Hoffstein	Brown University
Dr Jeffrey Hogan	The University of Newcastle
Ms Tamara Hogan (S)	The University of Melbourne
Dr Matthew Holden	The University of Queensland
Dr Andrew Holder	None
Mr Joshua Holroyd (S)	The University of Sydney
Mr Chris Hone (S)	The University of Sydney
Dr Mumtaz Hussain	La Trobe University
Dr Deborah Jackson	La Trobe University
Dr Marcel Jackson	La Trobe University
Mr Ponpot Jartnillaphand (S)	Curtin University
Ms Adrianne Jenner	Queensland University of Technology
Miss Sandra Jeyakumar (S)	Australian National University
Mr Leo Jiang (S)	University of Toronto
Dr Chunxi Jiao	The University of Sydney
Mr John bailie John bailie (S)	The University of Auckland
Prof Michael Johnson	Macquarie University
Mr Daniel Johnston (S)	UNSW Canberra
Mr Wil Jordan (S)	The University of Queensland
Mrs Riya Jose (S)	Cochin University of Science and Technology
Prof Nalini Joshi	The University of Sydney
Assoc Prof Masoud Kamgarpour	University of Queensland
Mr Parsa Kavkani (S)	The University of Adelaide
Dr Andrew Kels	International School for Advanced Studies (SISSA)
Ms Carolyn Kennett	Macquarie University
Mr Muhammad Nauman Khan (S)	RMIT University
Miss Isabella Kieu (S)	The University of Queensland
Dr Jongchon Kim	City University of Hong Kong
Dr Vassili Kitsios	CSIRO
Dr Peter Koltai	Freie Universiteit Berlin
Prof Swastik Kopparty	University of Toronto
Prof Bernd Krauskopf	University of Auckland
Assoc Prof Jonathan Kress	University of New South Wales
Prof Alexander Kruger	Federation University Australia
Dr Veronika Kuchta	The University of Queensland
Miss Pavini Kumaresan (S)	None
Dr Kwok-Kun Kwong	University of Wollongong
Dr Ramiro Augusto Lafuente	The University of Queensland
Prof Carlo Laing	Massey University
Dr Bishnu Lamichhane	The University of Newcastle
Dr Mat Langford	The University of Newcastle
Mrs Jo-ann Larkins	Federation University Australia
Mr Tomas Lasic Latimer (S)	The University of Sydney
Mr John Lawton (S)	Deakin University
Mr Mihai-Silviu Lazorec	"Alexandru Ioan Cuza" University of Iasi
Dr Ian Le	Australian National University
Dr Quoc Thong Le Gia	University of New South Wales
Prof Eon-Kyung Lee	Sejong University
Mr Ethan Simpson Lee (S)	UNSW Canberra

Prof Man-Chun Lee	The Chinese University of Hong Kong
Prof Sanghyuk Lee	Seoul National University
Mr Nicol Leong (S)	UNSW Canberra
Mr Thomas Lesgourgues (S)	UNSW Sydney
Dr Ji Li	Macquarie University
Dr Libo Li	University of New South Wales
Mr Vincent Liang (S)	The University of Melbourne
Assoc Prof Anthony Licata	Australian National University
Dr Scott Boivin Lindstrom	Curtin University
Assoc Prof Jon Links	The University of Queensland
Prof Oleg Lisovyy	Université de Tours
Ms Eloise Little (S)	The University of Sydney
Dr Jiakun Liu	University of Wollongong
Mr Qingwei Liu (S)	The University of Melbourne
Miss Xuemei Liu (S)	University of South Australia
Ms Tiffany Y. Y. Lo (S)	The University of Melbourne
Prof John Loxton	Western Sydney University
Mr xilin lu (S)	Australian National University
Dr Thiansiri Luangwilai	Navaminda Kasatriyadhiraj Royal Thai Air Force Academy
Mr Lukas Lukas Anagnostou (S)	None
Mr Xintao Luo (S)	The Australian National University
Mr Matthew Mack (S)	The University of Melbourne
Mr Matthew Madigan (S)	University of Queensland
Mr Arunmaran Mahenthiram (S)	University of South Australia
Mr Vishnu Mangalath (S)	None
Dr Daniel Francis Mansfield	University of New South Wales
Dr Greg Markowsky	Monash University
Dr Ian Marquette	University of Queensland
Miss Ada Masters (S)	None
Dr Daniel Mathews	Monash University
Mr Anant Mathur (S)	UNSW Sydney
Prof Chris Matthews	Aboriginal and Torres Strait Islander Mathematics Alliance
Prof Marta Mazzocco	University of Birmingham
Dr Geordie Drummond McBain	None
Assoc Prof James McCoy	The University of Newcastle
Mr Sean McGowan (S)	The University of Adelaide
Mr Sean McGowan (S)	The University of Adelaide
Dr Linda McIver	Australian Data Science Education Institute
Dr Robby McKilliam	Myriota
Assoc Prof William McLean	University of New South Wales
Mr Timothy McMahon	None
Dr Benjamin McMillan	The University of Adelaide
Dr Benjamin Blake McMillan	The University of Adelaide
Dr Peter McNamara	The University of Melbourne
Dr Ross McVinish	The University of Queensland
Dr Charles Meaney	None
Mr Joshua Mercurio (S)	The University of Adelaide
Mrs Melanie Merriman	The University of Newcastle
Assoc Prof Michael Meylan	The University of Newcastle
Assoc Prof Mike Meylan	The University of Newcastle
Mrs Mahtab Mohtasham khani (S)	UNSW Canberra
Dr Sarat Babu Moka	Macquarie University
Dr Carmine Monetta	University of Salerno
Dr Ross Moore	Macquarie University
Dr Kerri Morgan	Deakin University
Dr Anthony Morphett	The University of Melbourne
Mr Benjamin Morris (S)	Australian National University

Miss Ellena Moskovsky (S)	Monash University
Assoc Prof Intan Muchtadi-Alamsyah	Institut Teknologi Bandung (ITB)
Mr Vishal Mudgal	None
Mr Jonathan Mui (S)	The University of Sydney
Dr Stephen Muirhead	The University of Melbourne
Dr Alexander Mundey	University of Wollongong
Mr GyeongHyeon Nam (S)	The University of Queensland
Prof Makoto Narita	National Institute of Technology, Okinawa College
Prof Amnon Neeman	Australian National University
Assoc Prof Mark Nelson	University of Wollongong
Dr Garry Newsam	The University of Adelaide
Dr Abraham Ng	University of Wollongong
Mr Kie Seng Nge (S)	The Australian National University
Mr Chau Nguyen (S)	None
Mrs Lien Nguyen (S)	RMIT University
Prof Quoc Hung NGUYEN	Chinese Academy of Sciences
Dr Yuri Nikolayevsky	La Trobe University
Ms Madeline Nurcombe (S)	The University of Queensland
Dr Terence O'Kane	CSIRO
Mr Peter Olanipekun (S)	Monash University
Assoc Prof Andriy Olenko	La Trobe University
Dr Judy-anne Osborn	The University of Newcastle
Prof Hinke Osinga	The University of Auckland
Dr Alina Ostafe	University of New South Wales
Miss Hui Ouyang (S)	University of British Columbia, Okanagan
Dr Anthony Overmars	None
Mr George Papadopoulos (S)	The University of Sydney
Mx Bowen Parnell (S)	None
Miss Vinesha Peiris (S)	Swinburne University of Technology
Dr Richard Pennifold	None
Mr David Perrella (S)	The University of Western Australia
Prof Peter Petersen	University of California Los Angeles
Dr David Pfefferlé	The University of Western Australia
Mr Toan Pham (S)	The University of Queensland
Dr Adam Piggott	Australian National University
Mx João Vitor Pinto e Silva (S)	The University of Newcastle
Dr Giorgio Poggesi	The University of Western Australia
Mrs Cassandra Portelli	Hunter School of Performing Arts
Dr John Power	Macquarie University
Prof Cheryl Praeger	The University of Western Australia
Mr Valerian Pratama (S)	Bandung Institute of Technology
Prof Geoff Prince	La Trobe University
Dr Artem Pulemotov	The University of Queensland
Prof Jessica Purcell	Monash University
Dr Anna Puskas	The University of Queensland
Assoc Prof Youming Qiao	University of Technology Sydney
Mr ZHIHAO QIAO (S)	The University of Queensland
Dr Milena Radnovic	The University of Sydney
Mr Rafael Rafael Pereira Lima (S)	Victoria University of Wellington
Prof Arun Ram	The University of Melbourne
Mr Cale Rankin (S)	None
Prof Asha Rao	Royal Melbourne Institute of Technology
Dr Christopher Raymond	The Australian National University
Dr Colin David Reid	The University of Newcastle
Dr Adam Rennie	University of Wollongong
Dr David Ridout	The University of Melbourne
Dr Emily Riehl	Johns Hopkins University
Prof John Roberts	University of New South Wales
Dr Lindon Roberts	Australian National University

Dr Marcy Robertson	The University of Melbourne
Dr Chris Roe	Retired
Mr Pieter Roffelsen	The University of Sydney
Dr Keith Rogers	Spanish National Research Council
Dr Fred Roosta	University of Queensland
Dr Vera Roshchina	UNSW Sydney
Prof Joshua Ross	The University of Adelaide
Dr Nathan Ross	The University of Melbourne
Prof Zeev Rudnick	Tel Aviv University
Mr Mitchell Ryan (S)	The University of Queensland
Prof Mohammad Sajid	Qassim University
Miss Aldhytha Karina Sari (S)	UNSW Sydney
Dr James Saunderson	Monash University
Mrs Ronél Scheepers (S)	QUT
Prof Gerd Schmalz	University of New England
Dr Jelena Schmalz	University of New England
Prof Susan Scott	Australian National University
Dr Travis Scrimshaw	Osaka City University
Dr Katherine Seaton	La Trobe University
Mr Nicholas Seaton (S)	University of Wollongong
Joaquim Serra	ETH Zurich
Dr Morteza Shahpari	The University of Adelaide
Mr Akshay Sharma (S)	Swinburne University of Technology
Ms Himani Sharma (S)	The Australian National University
Mr Jordan Shaw-Carmody (S)	The University of Newcastle
Prof Chun-Yen Shen	National Taiwan University
Ms Yang Shi	Flinders University
Prof Igor Shparlinski	UNSW Sydney
Prof Vladimir Shpilrain	City University of New York
Prof Harvinder Sidhu	University of New South Wales
Dr Leesa Sidhu	University of New South Wales Canberra
Dr Adam Sikora	Macquarie University
Mr Aleksander Simonic (S)	University of New South Wales Canberra
Prof Aidan Sims	University of Wollongong
Dr Brailey Sims	The University of Newcastle
Mr dharmendra Singh	MANSW
Dr Matthew Paul Skerritt	RMIT University
Prof Ian Sloan	University of New South Wales
Dr Jonathan Spreer	The University of Sydney
Miss Abirami Srikumar (S)	UNSW Sydney
Dr Eva Stadler	UNSW Sydney
Mr James Stanfield (S)	None
Ms Valeriia Starichkova (S)	UNSW Canberra
Prof Yury Stepanyants	University of Southern Queensland
Prof Erik Stern	Weber State University
Mr Kyle Jacob Stevens (S)	The University of Newcastle
Mr Joshua Stevenson (S)	University of Tasmania
Mr Alan Stoneham (S)	UNSW Sydney
Dr Michelle Strumila (S)	Monash University
Dr Nadia Sukhorukova	Swinburne University of Technology
Dr Jeremy Sumner	University of Tasmania
Dr Budhi Surya	Victoria University of Wellington
Mrs Sona Taheri	Royal Melbourne Institute of Technology
Dr Matthew Tam	The University of Melbourne
Prof Qihe Tang	University of New South Wales
Mr Giacomo Tendas (S)	Macquarie University
Prof Tom ter Elst	University of Auckland
Dr Venta Terauds	University of Tasmania
Prof Natalie Thamwattana	The University of Newcastle

Mr Adam Thompson (S)	The University of Queensland
Ms Emily Thompson (S)	Monash University
Mr Jack Thompson (S)	The University of Western Australia
Dr Lauren Thornton	University of the Sunshine Coast
Prof Gang Tian	Peking University
Prof Chris Tisdell	University of New South Wales
Mr Jesse Benjamin Tonkin (S)	The University of Adelaide
Dr Stephan Tornier	The University of Newcastle
Dr TriThang Tran	The University of Melbourne
Assoc Prof Timothy Trudgian	UNSW Canberra
Mr Daniel Tubbenhauer	The University of Sydney
Dr Ilknur Tulunay	UNSW Sydney
Prof Levent Tuncel	University of Waterloo
Assoc Prof Leo Tzou	The University of Sydney
Dr Julien Ugon	Deakin University
Mr Daniel Uteda (S)	The University of Melbourne
Mrs Aparna Pradeep Vadakke Kovilakam (S)	Cochin University of Science and Technology
Mr Sahand Vahidnia (S)	UNSW Canberra
Dr Frank Valckenborgh	Macquarie University
Prof Enrico Valdinoci	The University of Western Australia
Dr Roland van der Veen	University of Groningen
Prof Mathai Varghese	The University of Adelaide
Mr Ivo De Los Santos Vekemans (S)	Australian National University
Prof Dominic Verity	Macquarie University
Dr Geetika Verma	RMIT University
Prof Felipe Voloch	University of Canterbury
Ms Jie Wang (S)	Federation University Australia
Prof Xu-Jia Wang	Australian National University
Dr Yuguang Wang	Max Planck Institute; UNSW
Prof Ole Warnaar	The University of Queensland
Dr Simon Watt	UNSW Canberra
Mr Zachary James Wegert (S)	Queensland University of Technology
Prof Guofang Wei	University of California, Santa Barbara
Prof Yong Wei	University of Science and Technology of China
Dr Glen Edward Wheeler	University of Wollongong
Dr Valentina-Mira Wheeler	University of Wollongong
Miss Chloe Wilkins (S)	The University of Newcastle
Mr Kenny Wiratama (S)	The Australian National University
Mr Hosea Wondo (S)	The University of Sydney
Assoc Prof jae kyung woo	University of New South Wales
Mr Ben Wootton (S)	University of New England
Dr Caroline Wormell	CNRS
Dr Haotian Wu	The University of Sydney
Prof Aihua Xia	The University of Melbourne
Prof xiao xiong	Harbin Institute of Technology
Dr Kazutoshi Yamazaki	None
Mr Liam Yemm (S)	Monash University
Dr David Yost	Federation University Australia
Dr Po-Lam Yung	The Australian National University
Prof Tyson Yunkaporta	Deakin University
Dr Erchuan Zhang	Edith Cowan University
Dr Yang Zhang	The University of Sydney
Dr Yinan Zhang	Australian National University
Dr Zhou Zhang	The University of Sydney
Dr Zongzheng Zhou	Monash University
Dr Jonathan Julian Zhu	Australian National University
Mr Joel Zimmerman (S)	University of Wollongong
Dr Lukas Zobernig	The University of Auckland

Abstracts

1. Plenary

1.1. Universal robustness-promoting structures in biochemical reaction networks

Speaker: Robyn Patrice Araujo (Queensland University of Technology)
Time: 11:00 Fri 10 December
Place(s):
Author(s): Robyn Patrice Araujo

Although all living systems are subject to the laws of physics and chemistry, the notion of 'function', or purpose, differentiates biology from other natural sciences. In particular, evolutionary selection for function has given rise to vast and elaborate networks of interacting molecules within each living cell, comprising mostly proteins, which allow cells to interpret their external environments and make decisions on appropriate responses. These signalling networks are now recognised to be a rich source of fascinating mathematical problems. In this lecture, I will present some of our recent research on the fundamental design principles of biological signalling networks, with an emphasis on the special biological function known as Robust Perfect Adaptation (RPA). Importantly, RPA corresponds to a special case of a defining problem in classical automatic control – namely, the robust asymptotic tracking of a desired trajectory (the 'setpoint' of the system), while rejecting unwanted disturbances. In biological contexts, such disturbances may arise in a wide variety of forms, including mutations, persistent alterations in a cell's external environment, molecular concentration variations, or an external stimulus to a cellular signalling network. We have recently shown that all RPA-capable collections of interacting molecules are able to construct integrals by exploiting special structural constraints on their underlying chemical reactions, thereby implementing the well-established engineering strategy known as integral control. We have also suggested a resolution to the complexity-robustness paradox through the discovery that robust adaptive signalling networks must be decomposable into topological basis modules of just two possible types. This newly-discovered modularisation, and the remarkable computational potential of complex bionetworks, has important implications for evolutionary biology, embryology and development, cancer research and drug development.

1.2. Jonathan Borwein: Life and Legacy

Speaker: Richard P Brent (Australian National University)
Time: 13:00 Wed 8 December
Place(s):
Author(s): Richard P Brent

Jonathan M. Borwein (1951-2016) was a prolific mathematician whose career spanned several countries (UK, Canada, USA, Australia) and whose many interests included analysis, optimization, number theory, special functions, experimental mathematics, mathematical finance, mathematical education, and visualization. This talk will outline his life and mathematical legacy.

1.3. Data-driven mathematical models for malaria response

Speaker: Jennifer Flegg (The University of Melbourne)
Time: 11:00 Thu 9 December
Place(s):
Author(s): Jennifer Flegg

The effect of malaria on the developing world is devastating. Each year there are more than 200 million cases and over 400,000 deaths, with children under the age of five the most vulnerable. Ambitious malaria elimination targets have been set by the World Health Organization for 2030. These involve the elimination of the disease in at least 35 countries. However, these malaria elimination targets rest precariously on being able to treat the disease appropriately; a difficult feat with the emergence and spread of antimalarial drug resistance.

In this talk, I will introduce several statistical and mathematical models that can be used to monitor malaria transmission and to support malaria elimination. For example, I'll present statistical models that allow the emergence and spread of antimalarial drug resistance to be monitored, mechanistic models that capture the role of bioclimatic factors on the risk of malaria and optimal geospatial sampling schemes for future malaria surveillance. I will discuss how the results of these models have been used to update public health policy and support ongoing malaria elimination efforts.

1.4. My Journey as a Goori Mathematician

Speaker: Chris Matthews (Aboriginal and Torres Strait Islander Mathematics Alliance)
Time: 17:00 Wed 8 December
Place(s):
Author(s): Chris Matthews

In 2018, the Australian Mathematical Society (AustMS) establish its first Equity, Diversity and Inclusion (EDI) Committee of which I am a proud member. One of the outcomes of this Committee was establishing a permanent lecture devoted to EDI issues at the AustMS annual conference. This lecture series is named after Dr Mandawuy Yunupingu. In the 1980s, he became the first Yolngu principal at Yirrkala School, who worked with many Yolngu and non-Indigenous educators to create an educational paradigm that was based on the relationship between, and the valuing of, Yolngu and Western knowledge. According to Dr Yunupingu, the closet connection between these two knowledge systems is mathematics. This address will focus on my journey as a Goori Mathematician as a way to explore the meaning of Equity, Diversity and Inclusion in relation to Indigenous people and mathematics. I will take this opportunity to explore the vision of Dr Yunupingu and will argue that the Mathematics Community needs to embrace a much deeper understanding of Indigenous knowledges. This is how we will improve mathematics education for Indigenous learners and create meaningful space for Indigenous people in mathematics that will enrich the discipline.

1.5. From path induction to arrow induction and the dependent Yoneda lemma

Speaker: Emily Riehl (Johns Hopkins University)
Time: 09:30 Wed 8 December
Place(s):
Author(s): Emily Riehl

Mathematics students learn a powerful technique for proving theorems about an arbitrary natural number: the principle of mathematical induction. This talk introduces two closely related proof techniques called “path induction” and “arrow induction.” The first encapsulates Per Martin-Löf’s elimination rule for the identity type and can be thought of as an expression of Leibniz’s “identity of indiscernibles.” Informally it says that to prove a statement involving two objects x and y of the same type and an identification between them you might as well assume that y is in fact x and that identification is trivial. In homotopy type theory, identifications are thought of as “paths,” which leads one to imagine the potential for “directed paths” between objects. “Arrow induction” is the corresponding induction principle, which, as we explain, can be understood as a “dependent” generalization of the Yoneda lemma from category theory. This involves joint work with Dominic Verity and Mike Shulman.

1.6. Beyond uniform distribution

Speaker: Zeev Rudnick (Tel Aviv University)
Time: 18:00 Tue 7 December
Place(s):
Author(s): Zeev Rudnick

The study of uniform distribution of sequences is more than a century old, with pioneering work by Hardy and Littlewood, Weyl, van der Corput and others. More recently, the focus of research has shifted to much finer quantities, such as the distribution of nearest neighbor gaps and the pair correlation function. Examples of interesting sequences for which these quantities have been studied include the zeros of the Riemann zeta function, energy levels of quantum systems, and more. In this expository talk, I will discuss what is known about these examples and discuss the many outstanding problems that this theory has to offer.

1.7. Singularities of Space-Time

Speaker: Susan Scott (Australian National University)
Time: 09:30 Thu 9 December
Place(s):
Author(s): Susan Scott

Einstein’s general theory of relativity is proving, arguably, to be the most successful theory of modern physics. Although they are very difficult to obtain, there are now many solutions to the Einstein field equation, some more “physical” than others. An intriguing and confusing aspect of these solutions is that many of them have associated singularities - places in space-time where things go badly wrong. The study of these singularities by mathematical relativists forms an important and active sub-field of general relativity. In this talk we will explore the nature of these singularities. This will include specific examples occurring in well-known solutions, a categorisation of singularities, and a look at the central issue of exactly where are these singularities located in space-time. We will also address the question, which lies at the heart of general relativity theory, as to whether these singularities are a natural prediction of Einstein's theory, or merely an artefact of the various "idealised" assumptions which we place on space-time in order to give us some hope of solving the fiendishly complex Einstein field equation.

1.8. Fractional minimal surfaces: an invitation for the skeptics (and the convinced)

Speaker: Joaquim Serra (ETH Zurich)
Time: 09:00 Fri 10 December
Place(s):
Author(s): Joaquim Serra

Elliptic operators of fractional order were popularized, mainly thanks to Luis Caffarelli, during the early 2000's. Suddenly, we learnt that every classical PDE had a fractional counterpart (or even more than one in some cases!). Also, fractional versions of most important techniques and results in PDE were developed. In this context, the invention in the late 2000's of fractional minimal surfaces may not seem a very striking milestone. Over the years, however, the interest and depth of these new surfaces is becoming unquestionable, to the point that they may be a fundamental tool in order to better understand certain (famously delicate) questions on classical minimal surfaces, such as Yau's conjecture. In the talk I will describe some very recent works that, I hope, may help to convince a fraction of the remaining skeptics about the beauty and usefulness of fractional minimal surfaces.

1.9. Ricci flow on Fano manifolds

Speaker: Gang Tian (Peking University)
Time: 11:30 Tue 7 December
Place(s):
Author(s): Gang Tian

Ricci flow was introduced by Hamilton in early 80s. It preserves the Kahlerian structure and has found many applications in Kahler geometry. In this expository talk, I will focus on Ricci flow on complex manifolds with positive first Chern class, often referred as Fano manifolds. I will first survey some results in recent years, then I will discuss my joint work with Li and Zhu. Some related problems may be also discussed.

2. Algebra

2.1. Construction of RGD-systems over F_2

Speaker: Sebastian Bischof (Justus Liebig Universität Gießen)
Time: 19:30 Tue 7 December
Place(s):
Author(s): Sebastian Bischof

Let G be a group endowed with an RGD-system of type (W, S). Let U_+ be the subgroup of G which is generated by all the root groups corresponding to positive roots. Then U_+ is the direct limit of certain subgroups U_w with $w \in W$. Given suitable groups U_w for any $w \in W$, let U_+ be the direct limit of these groups and assume that $U_w \to U_+$ is injective for any $w \in W$. In this talk we will show that under certain conditions the group U_+ extends to an RGD-system. In such an RGD-system the root groups will have order 2.

2.2. Isomorphisms and automorphisms of group divisible designs

Speaker: Yudhistira Andersen Bunjamin (UNSW Sydney)
Time: 08:30 Wed 8 December
Place(s):
Author(s): R. Julian R. Abel, Yudhistira A. Bunjamin and Diana Combe

A k-GDD, or *group divisible design* with block size k, is a triple $(X, \mathcal{G},\ mathcalB)$ where X is a set of *points*, $mathcalG$ is a partition of X into subsets (called *groups*) and $mathcalB$ is a collection of k-element subsets of X (called *blocks*) such that any two points from distinct groups appear together in exactly one block and no two distinct points from any group appear together in any block. There are a number of known necessary conditions for the existence of a GDD. However, these conditions are not sufficient.

Most work done on GDDs has been on existence but very little work has been done on the enumeration of such structures. This talk will focus on 4-GDDs. We will present the results of the enumeration of 4-GDDs with five groups of size 3 and two groups of size 6 and compare their automorphism groups.

Joint work with R. Julian R. Abel and Diana Combe.

2.3. Bounds on the Inducibility of Double Loop Graphs

Speaker: Su Yuan Chan (Deakin University)
Time: 18:30 Wed 8 December
Place(s):
Author(s): Su Yuan Chan, Kerri Morgan, Julien Ugon

In the areas of extremal graph theory, the problem of inducibility introduced by Pippenger and Golumbic in 1975 concerns the asymptotic maximum induced density for a given k-vertex graph H in any n-vertex graph G. The exact inducibility is known for only a handful of small graphs and some families of graphs. The exact inducibility for the family of cycles is known for $k < 6$. A natural next step is to look at graphs with cyclic properties, such as the family of double loop graphs. We determine new bounds on the inducibility for this family of graph and give a general construction for the bounds on the double loop graphs of order 6 and 7.

2.4. Discrete and free groups acting on locally finite trees

Speaker: Matthew Conder (The University of Auckland)
Time: 17:00 Tue 7 December
Place(s):
Author(s): Matthew Conder

We present an algorithm to decide whether or not a finitely generated subgroup of the isometry group of a locally finite simplicial tree is both discrete and free. The correctness of this algorithm relies on the following conjecture: every 'minimal' n-tuple of isometries of a simplicial tree either contains an elliptic element or satisfies the hypotheses of the Ping Pong Lemma. We will discuss computational evidence for this conjecture and some related applications.

2.5. On a duality for codes over non-abelian groups

Speaker: Heiko Dietrich (Monash University)
Time: 08:00 Fri 10 December
Place(s):
Author(s): Heiko Dietrich

Dougherty, Kim, Solé (2015) asked whether there is a duality for codes over non-abelian groups. We revisit this question and show that such a duality cannot be defined via a duality of a group lattice. We then study a variation that reduces to a group theoretic investigation; this investigation will be the main focus of the talk. This work is joint with Jeroen Schillewaert (University of Auckland).

2.6. Congruences of twisted partition monoids

Speaker: James East (Western Sydney University)
Time: 14:00 Fri 10 December
Place(s):
Author(s): James East

This is a report on an ongoing project with Nik Ruškuc (St Andrews) on congruences of monoids and other structures. The focus here is on finite-dimensional twisted partition monoids, which are countably infinite diagram monoids that keep track of "floating components" formed when composing partitions. Congruences of these monoids, and the lattices formed by them, are far more complex than for the associated non-twisted partition monoids. Nevertheless, they can be succinctly described in terms of certain $(n+1)\times\infty$ matrices. This description also leads to some interesting combinatorial and order-theoretic properties of the congruence lattices.

2.7. Equations in hyperbolic groups

Speaker: Murray Elder (University of Technology Sydney)

Time: 16:30 Fri 10 December

Place(s):

Author(s): Murray Elder

We show that the full set of solutions to systems of equations and inequations in a hyperbolic group, as shortlex geodesic words (or any regular set of quasigeodesic normal forms), can be computed in $\mathsf{NSPACE}(n^4 \log n)$.

Our work combines the geometric results of Rips, Sela, Dahmani and Guirardel on the decidability of the existential theory of hyperbolic groups with the work of computer scientists including Plandowski, Jeż, Diekert and others on PSPACE algorithms to solve equations in free monoids and groups using compression.

This is joint work with Laura Ciobanu, Heriot-Watt University.

2.8. Automorphism groups of Cayley graphs of Coxeter groups: when are they discrete?

Speaker: Michal Ferov (The University of Newcastle)

Time: 16:00 Fri 10 December

Place(s):

Author(s): Michal Ferov

Every group acting on a graph can be equipped with a topology coming from the action that makes it into a topological group. If the graph is connected and locally finite, this topology is totally disconnected and locally compact. In general, it is very hard to decide when is this topology discrete.

In a joint work with F. Berlai, we present a combinatorial characterisation (in terms of symmetry of the defining graph/Coxeter system) in the case then the graph is a Cayley graph of a Coxeter group.

2.9. The intersection graph of a finite simple group

Speaker: Saul Freedman (University of St Andrews)

Time: 14:30 Tue 7 December

Place(s):

Author(s): Saul Freedman

Given a binary relation on the subgroups or elements of a group G, it is natural to study the properties of the graph encoding this relation. One example is the intersection graph, whose vertices are the proper nontrivial subgroups of G, with two distinct subgroups joined by an edge if and only if their intersection is nontrivial. There has been particular interest in the intersection graph of a non-abelian finite simple group since 2010, when Shen proved that such a graph is connected, and posed questions about its diameter. In this talk, we will show that this diameter has a tight upper bound of 5, achieved only by the graphs of the baby monster group and certain unitary groups. We will also discuss applications of this result to certain graphs defined on the elements of a group.

2.10. The Kaplansky conjectures

Speaker: Giles Gardam (University of Muenster)

Time: 16:00 Tue 7 December

Place(s):

Author(s): Giles Gardam

Three conjectures on group rings of torsion-free groups are commonly attributed to Kaplansky, namely the unit, zero divisor and idempotent conjectures. For example, the zero divisor conjecture predicts that if K is a field and G is a torsion-free group, then the group ring K[G] has no zero divisors. I will discuss these conjectures and their relationship to other conjectures and properties of groups. I will then explain how modern solvers for Boolean satisfiability can be applied to them, producing the first counterexample to the unit conjecture.

2.11. Higman-Thompson groups of directed label-regular trees

Speaker: Roman Gorazd (The University of Newcastle)
Time: 19:00 Tue 7 December
Place(s):
Author(s): Roman Gorazd

In this talk we will look at trees that arise as path-spaces of certain In this talk we will look at trees that arise as path-spaces of certain graphs. We will determine the broader structure of these trees. Taking a look at the Higman-Thompson group of these trees, we will show instances of when those groups are isomorphic to the standard Higman-Thompson (which was shown to be finitely generated and virtually simple by Higman in 1974) group. Furthermore we will look at how their Higman-Thompson group acts on the boundary of the tree which is a Cantor Space, determining when it acts topologically transitive and when it acts minimally. Using these properties the results tie into the work of Nekrashevych, by identifying the alternating subgroup of the Higman-Thompson groups. This work contributes towards finding new examples of finitely generated simple totally disconnected locally compact groups.

2.12. Fast multiplication: some unsolved problems

Speaker: David Harvey (University of New South Wales)
Time: 16:00 Wed 8 December
Place(s):
Author(s): David Harvey

Joris van der Hoeven and I recently constructed an algorithm that computes the product of two n-bit integers in at most O(n log n) bit operations. In this talk I will discuss this algorithm and also some some related problems that remain unsolved.

2.13. Presenting the Demon

Speaker: Marcel Jackson (La Trobe University)
Time: 14:30 Fri 10 December
Place(s):
Author(s): Marcel Jackson

The set $\mathcal{B}_n$ of all binary relations on an n-element set is a semigroup under composition, which may be equivalent viewed as the set of Boolean matrices under matrix multiplication. This semigroup is unexpectedly complicated, even after taking into account the fact it embeds the symmetric group, the symmetric inverse semigroup, transformation semigroup and partial transformation semigroup. Unlike all of these, there is no precisely described generating set, due to the emergence of an exponential (in n) number of seemingly ad hoc "prime" elements. In this talk we revisit some of the many interesting and challenging facts about this semigroup, then revisit classical results to identify a generating set, modulo representative prime matrices, for the subsemigroup of all left total relations (equivalently, relations extending a transformation) and of full relations, and use this to describe a generating set for *The Demon*: the semigroup of $n \times n$ Boolean matrices under so-called *demonic composition.*

This work is joint with James East and Tim Stokes.

2.14. Chain Bundles and Category of Chains

Speaker: Riya Jose (Cochin University of Science and Technology)
Time: 19:00 Wed 8 December
Place(s):
Author(s): Riya Jose, P G Romeo

Category theory, in general is the mathematical theory of structures and system of structures which has come to occupy a central position in present day mathematics. Eilenberg and Mac Lane provide a purely abstract definition of a category in 1945. Accordingly a category C can be described as a set Ob whose members are objects of C and for every pair X, Y of objects of C there is Hom(X,Y) called morphisms from X to Y both satisfying certain specified conditions. In this paper we provide the construction and examples of a chain bundle category (a category we introduced in the paper entitled Category of Chain Bundles in Proc. ICSAA 2019, Kochi, India. Springer, 2021, pp. 215-229; but with slight modification). Further we construct chain bundle categories from directed graph and augmented simplicial categories. Finally we look into some categorical properties of the chain bundle categories with examples and the category of chains.

2.15. Minimum/Maximum values of the number of cyclic subgroups of a finite p-group

Speaker: Mihai-Silviu Lazorec (”Alexandru Ioan Cuza” University of Iasi)
Time: 17:00 Fri 10 December
Place(s):
Author(s): Mihai-Silviu Lazorec

Let $C(G)$ be the poset of cyclic subgroups of a finite group G and let $\mathcal{P}$ be the class of p-groups of order p^n $(n \geq 3)$. Consider the function $\alpha : \mathcal{P} \longrightarrow (0,1]$ given by $\alpha(G) = \frac{|C(G)|}{|G|}$. We determine the second minimum value of α, as well as the corresponding minimum points. Further, since the problem of finding the second maximum value of α was completely solved for $p = 2$, we focus on the case of odd primes and we outline a result in this regard.

2.16. p-nilpotency criteria for some commutator subgroups of a finite group

Speaker: Carmine Monetta (University of Salerno)
Time: 19:30 Wed 8 December
Place(s):
Author(s): Carmine Monetta

Let p be a prime. A finite group G is said to be p-nilpotent if and only if G has a normal p-complement, that is a normal subgroup having p'-order and p-power index in G. Criteria and sufficient conditions for a finite group to be p-nilpotent have been provided by several authors, mainly concerning with the p-nilpotency of the normalizer of some p-subgroup of G.
The aim of this talk is to present new p-nilpotency criteria for the terms of the lower central series and the terms of the derived series of a finite group, dealing with conditions on the order of their generators.
This is a joint work with Yerko Contreras-Rojas e Valentina Grazian.

2.17. On Orthogonal Theta-Circulant MDS Matrices

Speaker: Intan Muchtadi-Alamsyah (Institut Teknologi Bandung (ITB))
Time: 08:30 Fri 10 December
Place(s):
Author(s): Ichlas Adhiguna, Intan Muchtadi-Alamsyah

In 2019 Cauchois and Loidreau gave a necessary and sufficient condition for circulant MDS matrices using q-polynomial rings. In this paper, we prove the non-existence of certain orthogonal circulant MDS matrices. Then we give a necessary and sufficient condition for orthogonal theta-circulant matrices using q-polynomial rings.

2.18. Groups presented by length-reducing rewriting systems

Speaker: Adam Piggott (Australian National University)
Time: 15:00 Fri 10 December
Place(s):
Author(s): Adam Piggott

A long-standing program of research seeks to classify the groups presented by length-reducing rewriting systems that satisfy various convergence properties. The outstanding conjectures in the program concern the groups presented by finite *convergent* length-reducing rewriting systems. We report on several new results concerning such groups, including results obtained in collaboration with Heiko Dietrich, Murray Elder, Youming Qiao, and Armin Weiß.

2.19. Matrices indexed by (possibly infinite) partially ordered sets

Speaker: João Vitor Pinto e Silva (The University of Newcastle)
Time: 09:00 Wed 8 December
Place(s):
Author(s): João Vitor Pinto e Silva

To understand a theory, it is always good to work with objects that are easier to understand and work with. With that in mind, me and my supervisors developed a theory for infinite matrices indexed by posets over a ring. On the presentation I will talk about how to define these rings/groups, how to write these groups/rings as inverse limits of finite matrices rings, isomorphism problems and new simple totally disconnected groups that arise from the theory.

This work is a generalization of the work done by Peter Groenhout, Colin D. Reid and George A. Willis: https://arxiv.org/pdf/1911.09956.pdf

2.20. Building trees out of compact subgroups

Speaker: Colin David Reid (The University of Newcastle)
Time: 15:00 Tue 7 December
Place(s):
Author(s): Colin David Reid

(Joint work with Pierre-Emmanuel Caprace and Timothée Marquis.) We establish a new connection between local and large-scale structure in totally disconnected locally compact (t.d.l.c.) groups G, finding a sufficient condition in terms of compact subgroups for G to act on a tree with compact open arc stabilizers. The result is applicable to the local structure of Kac–Moody groups, specifically the question of whether any open subgroup splits as a direct product.

2.21. Automorphisms of seemed surfaces, modular operads and Galois actions

Speaker: Marcy Robertson (The University of Melbourne)
Time: 13:00 Fri 10 December
Place(s):
Author(s): Marcy Robertson

The idea behind Grothendieck-Teichmüller theory is to study the absolute Galois group via its actions on (the collection of all) moduli spaces of genus g curves. In practice, this is often done by studying an intermediate object: The Grothendieck-Teichmüller group, GT.

In this talk, I'll describe an algebraic gadget built from simple decomposition data of Riemann surfaces. This gadget, called an infinity modular operad, provides a simple model for the collection of all moduli spaces of genus g curves with boundaries and its automorphism group provides new insight into the Grothendieck-Teichmüller group.

2.22. On continuity of functors between locally presentable categories

Speaker: Giacomo Tendas (Macquarie University)
Time: 18:00 Wed 8 December
Place(s):
Author(s): Giacomo Tendas

We prove that for each locally finitely presentable category K there exists a regular cardinal k such that any finitary functor out of K (into another locally finitely presentable category) is continuous if and only if it preserves k-small limits; as a consequence we obtain a new adjoint functor theorem specifi

c to the finitary functors out of K. This is useful, for instance, to characterize the dualizable modules over a commutative ring R. We also generalize these results to the enriched setting and deduce, among other things, that a small V-category is accessible if and only if it is Cauchy complete.

2.23. Visualization for Petrov's odd unitary group

Speaker: Aparna Pradeep Vadakke Kovilakam (Cochin University of Science and Technology)
Time: 17:30 Tue 7 December
Place(s):
Author(s): Aparna Pradeep Vadakke Kovilakam

In 1976, L.N. Vaserstein and A.A. Suslin studied the freeness of projective modules over polynomial rings in the paper "Serre's problem on projective modules over polynomial rings and algebraic K-theory". They proved that a positive solution exists for Serre's problem for polynomial rings in five variables over an arbitrary field and also for polynomial rings in four variables over a principal ideal domain. For a given alternating matrix ϕ of size $2n$, Vaserstein proved the existence of two elementary matrices of size $2n-1$, namely α and β, which can be modified to get symplectic matrices with respect to ϕ.
In this article, we define a set of matrices $L(v)$ and $L(v)*$, analogous to Vaserstein-type matrices and prove that these are elementary matrices. We further show that, under certain conditions,$L(v)$ and $L(v)*$ belong to the odd unitary group introduced by V.A. Petrov in 2005. Finally, we prove that the group generated by these matrices is a conjugate of the Petrov's odd elementary hyperbolic unitary group.

3. Applied and Industrial Mathematics

3.1. Diabetic retinopathy early detection assisted by PDE constrained optimisation

Speaker: Xin An (UNSW Sydney)
Time: 16:00 Tue 7 December
Place(s):
Author(s): Xin An

Diabetic retinopathy remains one of the leading causes for vision impairment among working adults. The goal of this paper is to employ variational data assimilation to achieve early detection so as to prevent the condition from being irreversible. Method: The forward computational fluid dynamics simulation adopted by previous research has been proven to be insufficient due to the non-patient-specific boundary conditions. A PDE constrained optimisation approach is proposed to infer the blood flow information via manipulating inlets/outlets boundary conditions as control variables. Results: The assimilated solutions were compared to the in vivo results. It is shown a better agreement is achieved. It is also shown the control groups tend to have larger values in both total flow rate and average flow rate per inlet than the non-proliferative Diabetic retinopathy cases. Conclusion: The study demonstrates the variational data assimilation is a feasible methodology to assist diabetic retinopathy early detection. Significance: The approach enables the definition of the patient-specific models based on a small number of particle velocimetry experimental measurements which crucially need not be obtained at the vessels corresponding to the inlets/outlets.

3.2. Delay differential equations model of glucose- insulin dynamics: Towards a digital twin model

Speaker: Maia Nikolova Angelova (Deakin University)
Time: 17:30 Tue 7 December
Place(s):
Author(s): Maia Nikolova Angelova, Anatoli Ivanov and Sergiy Shelyag

Glucose-insulin dynamics is very central to the efficient functioning of the human body. We present a novel model of this dynamics based on delay differential equations (DDEs). The model based on first order DDEs represents the system in a more realistic way taking into account the delays in the glucose and insulin production and utilisation. However, the delays create a serious challenge for the analytical solutions based on traditional methods, Here, we propose a novel method for solving the system analytically based on non-linear maps. This is followed by comprehensive numerical solutions. Using experimental data from individuals with Diabetes type 2 and healthy controls, we were able to simulate the dynamic behaviour of the system and assess the time- dependent glucose-insulin utilisation.

3.3. A multiscale mathematical model of Plasmodium vivax transmission

Speaker: Md Nurul Anwar (The University of Melbourne)
Time: 17:00 Tue 7 December
Place(s):
Author(s): Md Nurul Anwar, Roslyn I. Hickson, Somya Mehra, James M. McCaw, Jennifer A. Flegg

Malaria is a disease caused by various Plasmodium species and the parasites are transmitted by Anopheles mosquitoes. Plasmodium vivax is distinct in its ability to stay dormant (as hypnozoites) in the liver and activate to raise further infection (relapse) after weeks, months or even a year. Mathematical models to capture the transmission dynamics of Plasmodium vivax have been developed, but most of them fail to properly capture the realistic dynamics of hypnozoites. These models that do capture the realistic behaviour are quite complicated to extend to incorporate other structures, like age and pregnancy status. Studies show children face more threat of dying compared to adults and current drugs to treat vivax is not recommended to pregnant women. We have developed a multiscale model that involves fewer equations at the population scale, and most importantly can capture the realistic behaviour of the P. vivax hypnozoites. We developed the population model using three compartments that involve susceptible, blood-stage infected and liver-stage infected individuals and embed a within-host model that captures the short-latency case where each hypnozoite activates or dies independently. This enables insights into the hypnozoite reservoir with a minimum of equations. We also performed a sensitivity analysis of our model over key parameters such as hypnozoite activation rate, hypnozoite death rate, mosquito biting rate and mosquitoes per human. Since our model captures the realistic dynamics of the hypnozoites it has the potential to become a key tool to study the best elimination strategies for P. vivax.

3.4. Time Series Forecasting Using Smoothing Ensemble Empirical Mode Decomposition and Machine Learning Techniques

Speaker: Mona Bahri (UNSW Canberra)

Time: 09:00 Thu 9 December

Place(s):

Author(s): Mona Z. Bahri, S. Vahidnia, M. Mohtashamkhani

Time series forecasting is one of the most important features in time series analysis. When the time series is non-stationary and non-linear, forecasting become more challenging. Recently, machine leaning techniques is widely used to predict time series. However, for non-stationary and non-linear data, machine learning alone fail to predict the correct features of the time series. In this paper, to improve the results of forecasting for non-stationary and non-linear signals a combined prediction model is suggested. This model is a combination of the smoothing ensemble empirical mode decomposition (SEEMD) and some machine learning techniques such as: the long short-term memory (LSTM) networks and convolutional neural networks (CNN). First the SEEMD method is used to decompose the data into its embedded modes, called intrinsic mode functions (IMF). This will eliminate the possible noise and outliers in the data. Then, a combination of LSTM networks and CNNs prediction models are established for all the IMFs to train and forecast the time series. To evaluate the accuracy of the results, a range of synthetic non-stationary and non-linear data, including data with linear trend as well as noise, are used.

The results shows that the proposed combined model can forecast non-stationary and non-linear time series with high accuracy across all synthetic data that is used in this paper. The LSTM network is suitable for predicting the high and low frequencies as it can learn and predict signals with sinusoidal patterns. The LSTM networks predicted the high frequency IMFs with $R^2 = 0.9218$ and the mean absolute error (MAE) of 0.04340, and the low frequency IMFs with $R^2 = 0.99995$ and MAE of 0.0026. The CNN produced a more accurate results for trends with $R^2 = 0.99998$ and MAE of 0.0002.

3.5. Rayleigh–Bloch waves above the cut-off

Speaker: Luke Bennetts (The University of Adelaide)

Time: 14:00 Fri 10 December

Place(s):

Author(s): Luke Bennetts

When a plane incident wave interacts with a long line array of identical equally-spaced scatterers it would be reasonable to assume the solution away from the array ends is approximately the same as the corresponding infinite array. But this is not necessarily the case, as homogeneous solutions of the infinite-array problem known as Rayleigh–Bloch waves can be excited by the incident wave and propagate along the array, possibly dominating the local wave field and generating resonances. For acoustic sound-hard scatterers, classic solution methods have been used to study Rayleigh–Bloch waves for a wide class of scatterer shapes up to a cut-off frequency and connect them to primary resonances on finite arrays. I will present a transfer operator method, use it to study Rayleigh–Bloch waves above the cut-off and connect them to higher-order resonances on finite arrays.

3.6. Understanding the impact of Hotspots on the self-heating behaviour of Industrial stockpiles

Speaker: Matthew Berry (University of Wollongong)

Time: 08:30 Thu 9 December
Place(s):
Author(s): Matthew Berry

The ignition of large industrial stockpiles is a well known phenomenon. In many applications we seek to prevent ignition as this poses a hazard, particularly during transport, and also results in a loss of material. However in some applications, we seek to promote the ignition of the material due to the beneficial nature of the reaction products. In this talk I will be discussing the use of hotspots to induce ignition within large stockpiles. We examine some of the relationship between the Frank Kameknetskii parameters and temperature of the hotspot. We focus on the application to hotspots of filter cake from the Basic oxygen steel-making process.

3.7. An Informed Simulated Annealing method for coke reconstruction.

Speaker: Edward Bissaker (The University of Newcastle)

Time: 08:00 Thu 9 December
Place(s):
Author(s): Edward Bissaker

A vital and irreplaceable input for steel manufacture is a coal-derived solid fuel called coke. Digital reconstructions of coke are a valuable simulation tool to analyse and test coke properties. Digital reconstructions are produced by measuring the spatial statistical properties from a coke computed tomography (CT) image, then utilising a stochastic optimisation procedure to minimise the difference between the statistical measures from the CT image and an iteratively generated structure. This process creates novel yet statistically identical digital reconstructions. We propose a coke specific reconstruction method that incorporates some known physical properties of coke into the Simulated Annealing scheme via an additional convolution step. The convolution method increases the probability of an iteration performing an optimal step, thus reducing the number of iterations required to generate the reconstruction.

3.8. Conditionally integrable reaction-diffusion systems: Lotka-Volterra Type Predator-Prey

Speaker: Philip Broadbridge (La Trobe University)

Time: 13:00 Fri 10 December
Place(s):
Author(s): Philip Broadbridge

New classes of conditionally integrable systems of nonlinear reaction-diffusion equations are introduced. They are obtained by extending a well known nonclassical symmetry of a scalar partial differential equation to a vector equation. New exact solutions of nonlinear predator-prey systems with cross-diffusion are constructed. Infinite dimensional classes of exact solutions are made available for such nonlinear systems. Some of these solutions decay towards extinction and some oscillate or spiral around an interior fixed point. It is shown that the conditionally integrable systems are closely related to the original Lotka-Volterra system but the prey have a carrying capacity.

3.9. Advanced Mathematical Modelling For Improved Learning Cycle Assessment Natural Gas Wells' Performance

Speaker: Diane Donovan (The University of Queensland)

Time: 13:00 Thu 9 December
Place(s):
Author(s): Diane Donovan

Advanced Mathematical Modelling For Improved Learning Cycle Assessment Natural Gas Wells' Performance

Presented By

D. Donovan: The University of Queensland

In this study we developed techniques for forecast cumulative production for natural gas wells using a combination of fast-to-implement modelling methodologies, including Polynomial Chaos Expansion and Gaussian Processes proxy models coupled with populations of phenomenological models. These modelling techniques allowed for a reduction in forecast uncertainty and were shown to be effective techniques for extrapolating early-time data for gas well production from a field of wells in the Surat Basin, Queensland Australia. The implemented techniques strategically capture and capitalise on production trends across an entire gas field, even in the presence of early production transients. Our results demonstrated that learning cycles can be shortened, leading to reasonable forecasts, as well as meaningful and actionable insights.

This is joint work, funded in part by Origin Energy Australia, and is based on a forth coming paper in the SPE Journal. Joint authors were S. Ganpule, T. Nuralishahi, A. Smith: Origin Energy D Donovan, B Thompson, M. Azadi, S. Josserand, B. Thompson, T. Reay, L. Gay: The University of Queensland K. Burrage, P. Burrage, B. Lawson: Queensland University of Technology E. Yazici: Koc University, Turkey

3.10. Unravelling the correlation structure of noise in molecular pathways

Speaker: Lucy Ham (The University of Melbourne)

Time: 14:00 Thu 9 December

Place(s):

Author(s): Lucy Ham

Noise is ubiquitous at the molecular scale, and its presence has profoundly shaped cellular life. Understanding the sources of noise, how it is propagated, amplified, and attenuated has therefore become a cornerstone of modern cellular biology. Often seen as a nuisance, we here show how the correlation structure of noise can be exploited to dissect the molecular machinery underlying cellular processes.

Noise leads to extensive heterogeneity between cells subject to identical conditions, observable in “snapshot” distributions of molecule (e.g., transcript) numbers across ensembles of cells. Because temporal information is lost in such data, there are significant challenges for inferring the molecular mechanisms underlying gene transcription, as well as the causes of cell-to-cell variability. In particular, we typically cannot separate dynamic variability from within cells (“intrinsic noise”) from variability across the population (“extrinsic noise”). By developing stochastic models of gene expression that describe both intrinsic and extrinsic noise, we prove that it is in general impossible to identify the sources of variability, and consequently, the underlying transcription dynamics, from observed transcript abundance distributions alone. We then use these results to identify new experimental set-ups that can assist in resolving this non-identifiability. We show that multiple generic reporters from the same biochemical pathways (e.g., mRNA and protein) can infer magnitudes of intrinsic and extrinsic transcriptional noise, identifying sources of heterogeneity. Our theory is validated using synthetic data for genes with non-trivial gene expression dynamics; “pathway-reporter” approaches are remarkably robust to the details of the mRNA and protein synthesis dynamics, and compare favourably to the well-known, but often difficult to implement, dual-reporter methods.

3.11. A flexible framework for surveillance of Plasmodium knowlesi malaria in Indonesia

Speaker: Lucinda Harrison (The University of Melbourne)

Time: 15:00 Tue 7 December

Place(s):

Author(s): Lucinda Harrison

Disease surveillance activities are often resource-limited so should be optimised to achieve specific objectives. In a spatial context, the allocation of surveillance resources should therefore be based on our knowledge of the spatial distribution of the disease. But what should we do when there is extreme uncertainty in our understanding of the disease’s distribution?

Plasmodium knowlesi is a zoonotic strain of malaria that is increasingly found in across Southeast Asia and is now the most common cause of malaria in Malaysia. Previous surveillance of P. knowlesi malaria has been limited by diagnostic accuracy and resources available. As a result, P. knowlesi malaria case data is highly spatially biased.

There is now an active group of stakeholders working to facilitate study of P. knowlesi malaria in Indonesia, including the facilitation of human disease surveillance at existing primary healthcare centres. Given an existing geospatial model of relative P. knowlesi malaria risk and specific stakeholder sampling objectives, we develop a flexible decision workflow to support the selection of sites for human surveillance of P. knowlesi malaria, quantifying study aims into an objective surface and developing a meaningful definition of catchment around a healthcare centre.

3.12. Bifurcation analysis of a conceptual model for the Atlantic Meridional Overturning Circulation

Speaker: John bailie John bailie (The University of Auckland)

Time: 19:00 Tue 7 December

Place(s):

Author(s): John Bailie and Bernd Krauskopf

The Atlantic Meridional Overturning Circulation (AMOC) carries warm water into northern latitudes and returns cold deep waters back south. It is driven by salinity and temperature differences and gives rise to the Gulf Stream. The AMOC has been slowing down in the last century, and it has been proposed that melting from the Greenland ice sheets could further weaken the circulation.

We derive and study a conceptual box model for the North Atlantic Ocean, which takes into account freshwater influx from the melting ice. This model takes the form of a smooth planar vector field with a switching function between two regimes of ocean mixing. We present the bifurcation analysis of the limiting case of infinitely fast switching, which is piecewise-smooth and linear. We then discuss briefly the relevance of the different types of behavior thus identified for the smooth planar model. This analysis provides the foundation for future research involving delayed feedback loops involved in the AMOC.

3.13. Data driven stochastic parameterisation of the subgrid interactions between eddies, climate and topography in quasi-geostrophic simulations of the Antarctic Circumpolar Current

Speaker: Vassili Kitsios (CSIRO)

Time: 14:30 Fri 10 December

Place(s):

Author(s): Vassili Kitsios, Jorgen S. Frederiksen, Terence, J. O'Kane

In oceanic, and geophysical simulations in general, it is not possible to resolve all of the scales of motion. Instead one must resort to large eddy simulation (LES), where the large eddies are resolved on a computational grid, and the unresolved subgrid interactions are parameterized. If these interactions are not self-consistently parameterised, then the results become resolution dependent. This has been a significant and long standing problem since the earliest simulations of weather and climate. In typical approaches one starts with a physical hypothesis that then leads to a subgrid model. In contrast we will present an approach in which the model coefficients are calculated from the statistics of high resolution reference simulations, with physical interpretations made apostiori. The specific application here being a global ocean simulation representative of the Antarctic Circumpolar Current, with realistic ocean floor topography. There are five fundamental types of subgrid interactions: eddy-eddy; eddy-topographic; eddy-meanfield; meanfield-meanfield; and meanfield-topographic. The eddy-eddy interactions are those between the subgrid and resolved transient eddies, and dominate in simulations of the ocean at realistic resolutions. The eddy-meanfield interactions are those between the subgrid (resolved) eddies and the resolved (subgrid) meanfield. The meanfield-meanfield interactions are those between the subgrid and resolved meanfield. The eddy-topographic interactions are those between the subgrid (resolved) eddies and the resolved (subgrid) topography. The parameterization coefficients representing each of the above interaction classes are calculated from a high resolution reference direct numerical simulation (DNS) truncated back to lower LES resolutions. The kinetic energy spectra resulting from LES adopting these eddy viscosity coefficients replicate the spectra from the reference DNS.

3.14. Understanding the factors affecting the self-heating process of compost piles – two-dimensional analysis

Speaker: Thiansiri Luangwilai (Navaminda Kasatriyadhiraj Royal Thai Air Force Academy)

Time: 13:30 Thu 9 December

Place(s):

Author(s): Thiansiri Luangwilai, Harvinder Sidhu, Mark Nelson

Due to an increasing environmental concern, industrial composting has now become one of the most important processes to handle rising amount of bio-waste. Industrial compost piles contain large volumes of bulk organic materials. Normally, there are two main heat generation processes - oxidation of cellulosic materials and biological activity within compost piles. Biological heating generally occurs at lower temperature range, but it may be sufficiently high enough to kick-start the oxidation reaction. Nevertheless, biological heating is desirable and is a key component in composting operations. However, there are cases when the temperature within the compost piles increases beyond the ignition temperature of cellulosic materials which results in spontaneous ignition. Fires are fairly common at industrial composting facilities, such as those storing industrial waste products like municipal solid waste and landfills. These are normally manageable by the staff of the composting facilities, however there are notable large fire incidents reported around the world.

This investigation considers the self-heating process that occurs in a compost pile using a two-dimensional spatially-dependent model incorporating terms that account for self-heating due to both biological and oxidative mechanisms. The model consists of four mass-balance equations namely: energy, oxygen, vapour and liquid water. These equations are used to investigate the dynamic behaviour of the temperature within the compost piles under various conditions. The variation of temperature distribution of different compost pile geometries is also examined. The results are explained in the context of not only the optimal conditions for the biodegradation process, but also identifying regions where there may be possibilities of spontaneous ignition occurring within the compost pile.

3.15. Time of death: linking differential equations and linear regression

Speaker: Mark Nelson (University of Wollongong)

Time: 15:00 Fri 10 December

Place(s):

Author(s): Mark Nelson

An individual says that they left for a business meeting at 2 pm and returned at 8 pm to find their partner dead. The first temperature measurement of the dead body was made at 9pm. The individual says that they were home all morning and that their partner was alive and well when they left.

Students were asked to analyse the 'recorded' body temperature measurements and estimate the time-of-death, identifying the uncertainty in their estimate. They were then asked to discuss whether their predicted time-of-death was consistent with information provided by the individual.

In this presentation I discuss my experiences when I set questions in a second year applied mathematics subject which required students to use techniques from a first year statistics subject. What mistakes did students make? What mistakes did I make? Can students correctly estimate the time-of-death? How can this type of question be modified?

3.16. Population and temporal heterogeneity in recurrent malaria infections

Speaker: Eva Stadler (UNSW Sydney)

Time: 14:30 Tue 7 December

Place(s):

Author(s): Eva Stadler, Deborah Cromer, Somya Mehra, Adeshina I. Adekunle, Jennifer A. Flegg, James Watson, Cindy S. Chu, Timothy E. Schlub, Miles P. Davenport, David S. Khoury

Malaria is caused by Plasmodium parasites. The geographically most wide-spread, Plasmodium vivax, not only causes symptomatic infections in the blood (blood-stage infections) but also forms dormant parasites in the liver. These dormant parasites can activate much later and cause symptomatic blood-stage malaria infections known as relapses. Relapses contribute substantially to the transmission of parasites and P vivax disease burden. Nonetheless, relapses are not well-understood. Mathematical models of relapses commonly assume a constant relapse rate or periodic relapses. However, the rate at which dormant liver-stage parasites wake up is known to be influenced by factors that vary over time or between individuals such as other febrile infections, exposure, or immunity. For this reason, we include temporal or population heterogeneity in the rate of relapses to model recurrent P vivax blood-stage infections. To explore whether temporal or population variations in relapse risk play an important role in the observed pattern of malaria relapse, we fit these models to two published data sets. Using individual-level multiple recurrence data, we find strong evidence that population heterogeneity is a major factor determining the observed recurrence pattern. Moreover, analysis of the data by village indicates that heterogeneity in exposure may contribute to population heterogeneity in relapse risk.

3.17. More continuum modelling with the Lennard-Jones potential

Speaker: Kyle Jacob Stevens (The University of Newcastle)

Time: 19:30 Tue 7 December

Place(s):

Author(s): Kyle Jacob Stevens

Continuum modelling of intermolecular interactions using the 6-12 Lennard-Jones potential has been used to great effect since Girifalco first approximated C60 fullerenes with spheres of smeared carbon. When modelling an interaction using these methods, typically the molecules are replaced with regular structures, that have the original atoms smeared evenly across their surfaces, in order to make the resulting integrals easier to compute. When approximating molecules comprising a single atomic species, this is easily done (e.g. nanotubes with cylinders, fullerenes with ellipsoids, graphene with planes, etc...), however the story is different for heterogeneous molecules. The strategy for dealing with these varies, with some approximations just homogeneously smearing all the atoms together and averaging over the various interatomic constants, and other approximations break the molecule up into multiple monatomic structures. A third option is to approximate the molecule with a single structure and capture the heterogeneity in the density and interaction coefficients by replacing the constants with functions. In this talk I will introduce this third option and talk about its benefits in comparison to the other two options, along with some results modelling methane and coronene interactions that compare with molecular dynamics simulations.

3.18. Circular genome rearrangement models

Speaker: Joshua Stevenson (University of Tasmania)
Time: 16:30 Tue 7 December
Place(s):
Author(s): Joshua Stevenson

In the context of estimating genome rearrangement distances, genomes are often represented by signed permutations which form a group under composition. Further, the symmetry of genomes and rearrangement events can also be described algebraically. I will give an introduction to genome rearrangement modelling, and explore some of the questions that naturally arise when viewing this problem from an algebraic perspective, with the help of Python/SageMath for demonstrations.

3.19. Genome algebras in action

Speaker: Venta Terauds (University of Tasmania)
Time: 14:30 Thu 9 December
Place(s):
Author(s): Venta Terauds

We demonstrate some features of our recently introduced genome algebra framework by applying it to echinoderm mitochondrial genome data. In particular, the framework facilitates a fine-grained comparison of rearrangement models. We show how varying the underlying rearrangement model and the choice of genomic distance measure can affect the phylogeny that is produced.

4. Computational Mathematics

4.1. Limit theorems for filtered long-range dependent random fields

Speaker: Tareq Alodat (University of New South Wales)
Time: 13:00 Fri 10 December
Place(s):
Author(s): Tareq Alodat

This article investigates general scaling settings and limit distributions of functionals of filtered random fields. The filters are defined by the convolution of non-random kernels with functions of Gaussian random fields. The case of long-range dependent fields and increasing observation windows is studied. The obtained limit random processes are non-Gaussian. Most known results on this topic give asymptotic processes that always exhibit non-negative auto-correlation structures and have the self-similar parameter $H \in (\frac{1}{2}, 1)$. In this work, we also obtain convergence for the case $H \in (0, \frac{1}{2})$ and show how the Hurst parameter H can depend on the shape of the observation windows. Various examples are presented.

4.2. An origami Universal Turing machine

Speaker: Michael Assis (The University of Melbourne)
Time: 13:30 Fri 10 December
Place(s):
Author(s): Michael Assis

It has been known since 1996 that deciding whether a collection of creases on a piece of paper can be fully folded flat without causing self-intersection or adding new creases is an NP-Hard problem (Bern and Hayes). In their proof, a binary state was implemented as a pleat with the state corresponding to the pleat layering order; states then interact via pleat intersections. Building on some of the machinery of that result, we will present a method for constructing an origami NAND gate, leading to an origami Universal Turing machine.

4.3. Recent advances in unfitted finite element methods

Speaker: Santiago Badia (Monash University)
Time: 16:00 Wed 8 December
Place(s):
Author(s): Santiago Badia

In this talk, I will give an overview of the last advances in unfitted finite element techniques for the numerical approximation of partial differential equations.

Standard finite element methods (FEMs) require cumbersome and time-consuming body-fitted mesh generation. Conversely, unfitted FEMs provide a great amount of flexibility at the geometrical discretisation step. They can embed the domain of interest in a geometrically simple background grid (usually a uniform or an adaptive Cartesian grid), which can be generated and partitioned much more efficiently. Analogously, they can easily capture embedded interfaces.

As a result, unfitted FEMs are generating interest in applications with moving interfaces and varying domains. However, naive unfitted methods lead to unstable and severe ill-conditioned discrete problems, unless a specific technique mitigates the problem. Different techniques have been developed so far, which rely on perturbation (stabilisation) of the problem itself or a redefinition of finite element spaces based on aggregation meshes and discrete extension operators.

In this talk, we will describe the main challenges and methods. We will show links between different approaches and their effectiveness. We will cover topics like high-order extensions, space-time extensions, adaptive refinement and high-contrast interface problems. We will also discuss the geometrical discretisation and integration steps in the unfitted workflow. Numerical analysis results, experiments, and implementation aspects will be discussed.

4.4. Multi-objective structural optimisation of piezoelectric materials

Speaker: Vivien Challis (Queensland University of Technology)
Time: 14:00 Thu 9 December
Place(s):
Author(s): Vivien Challis

Structural optimisation combines the computational solution of partial differential equations with optimisation algorithms to enable the design of structures or microstructures for specific purposes. We consider the problem of designing optimised microstructures for piezoelectric materials. Piezoelectricity is the phenomenon in which certain materials convert mechanical energy to electrical energy and vice versa. Such materials are used in sensor, actuator, and energy harvesting technologies. We design new single-poled materials that maximise a linear combination of piezoelectric and stiffness properties.

This is joint work with Tony (A.P.) Roberts and Zach Wegert.

4.5. Dispersion relation preserving schemes

Speaker: Chris Christopher Williams (None)
Time: 17:00 Tue 7 December
Place(s):
Author(s): Chris Williams, Kenneth Duru

The numerical dispersion error for various types of hyperbolic PDEs is typically the dominant error when the computed solution contains high-frequency components. I will show how to construct stable high-order finite-difference schemes that currently have the best known dispersion error properties. These are the first such schemes that do not have catastrophic errors for wave propagation problems computed on marginal grids for non-smooth solutions. By having good dispersion error properties on marginal grids, these schemes require 4% of the computational resources compared with current schemes.

4.6. Hybrid symbolic-numeric computation for Bohemian matrices

Speaker: Rob Corless (University of Western Ontario)
Time: 15:00 Thu 9 December
Place(s):
Author(s): Rob Corless

A "Bohemian" family of matrices is a set of matrices with entries from a discrete finite set, typically integers, but not necessarily. The name comes from BOunded HEight Matrices of Integers (BOHEMI). Such matrices occur in a very wide array of contexts, of course; what seems to be interestingly new is to think about the common properties of these entities. Moreover, brute force computation can yield interesting insights, some of which can later be proved to be true. I'm mostly interested in eigenvalues of these families: see the density plots at www.bohemianmatrices.com to see why.

For some Bohemian families, ordinary eigenvalue software is perfectly adequate—although the families do tend to "stress test" the implementations. For other families, numerical surprises can be inherent; in those cases, exact computation can help explain the surprises, and yield surprises of their own. In this talk I use the Bohemian family of skew-symmetric tridiagonal matrices with population [1,i] to illustrate this.

4.7. Quaternion-valued wavelets in colour image processing

Speaker: Neil Kristofer Dizon (The University of Newcastle)
Time: 16:00 Tue 7 December
Place(s):
Author(s): Neil D. Dizon, Jeffrey A. Hogan

Quaternions have been used to represent colour images. With such a representation of a colour image, colour image channels (e.g. red, green and blue components) can be processed holistically rather than separately. Recently, quaternion-valued wavelets on the plane have been constructed by formulating quaternionic wavelet architecture as a feasibility problem. With these novel quaternion-valued wavelets, a holistic and wavelet approach to colour image compression, enhancement, segmentation and denoising are now viable. In this talk, we revisit the feasibility approach to quaternionic wavelet construction. We also present our preliminary results in applying quaternion-valued wavelets to colour image processing.

4.8. An arbitrary-order robust polygonal scheme for the Reissner-Mindlin plate problem

Speaker: Jerome Droniou (Monash University)
Time: 14:30 Tue 7 December
Place(s):
Author(s): Daniele A. Di Pietro, Jerome Droniou

We present a numerical method, for the Reissner-Mindlin plate problem, that is applicable on generic polygonal meshes, has an arbitrary order of accuracy and whose lowest order is fully robust with respect to the plate thickness. The method is designed using the Discrete de Rham complex, and inherits its robustness from a key commutation property between interpolator and discrete differential operators. Numerical results confirm the accuracy of the method, the robustness at the lowest order, and also shows that higher order versions also display a stronger robustness than the theoretical analysis predicts.

4.9. Upwind Summation By Parts Finite Difference Methods for Large Scale Elastic Wave Simulations In Complex Geometries

Speaker: Kenneth Duru (The Australian National University)
Time: 14:30 Thu 9 December
Place(s):
Author(s): Kenneth Duru, Christopher Williams and Frederick Fung

High-order accurate summation-by-parts (SBP) finite difference (FD) methods constitute efficient numerical methods for simulating large-scale hyperbolic wave propagation problems. Traditional SBP FD operators that approximate first-order spatial derivatives with central-difference stencils often have spurious unresolved wave-modes in their numerical solutions. On marginally resolved computational grids, these spurious wave-modes have the potential to destroy the accuracy of numerical solutions for a first-order hyperbolic partial differential equation, such as the elastic wave equation. To ensure the accuracy of numerical solutions of the three space dimensional (3D) elastic wave equation in complex geometries, we discretise the 3D elastic wave equation with a pair of non-central (upwind) finite-difference stencils, on boundary-conforming curvilinear meshes. Using the energy method we prove that the numerical method is stable, and energy conserving. Furthermore, computational results show the robustness of the scheme. We present numerical simulations of the 3D elastic wave equation in heterogeneous media with complex non-planar free surface topography, including numerical simulations of community developed seismological benchmark problems. Our results show that the upwind SBP operators are more robust and less prone to numerical dispersion errors on marginally resolved meshes when compared to traditional SBP operators, thereby increasing efficiency.

4.10. On accurate numerical simulations of nonlinear dynamic shear ruptures on non-planar faults embedded in 3D elastic solids using upwind finite difference methods

Speaker: Frederick Fung (Australian National University)

Time: 16:30 Tue 7 December

Place(s):

Author(s): Frederick Fung, Kenneth Duru, Christopher Williams

Numerical simulations of nonlinear frictional sliding along interfaces embedded in elastic solids are of utmost importance in science and engineering. For example, earthquake source processes can be modelled by spontaneously propagating shear ruptures along internal interfaces known as faults in elastic solids. This problem is both numerically and computationally challenging because of the unprecedented large gradients generated by nonlinear coupling of fields across the interface and the presence of discontinuous solutions on the fault. In this talk, we derive and analyse efficient numerical methods for accurate numerical simulations of nonlinear dynamic shear ruptures on non-planar faults embedded in 3D elastic solids using finite difference methods. Specifically, we demonstrate that the dual-pair summation by parts (SBP) finite difference (FD) operators [K. Mattsson JCP 2017] generate spurious catastrophic high-frequency wave modes that do not diminish with mesh refinement. Meanwhile, our new dispersion relation preserving dual-pair SBP operators [C. Williams and K Duru 2021] have superior numerical dispersion relation properties and do not support spurious modes. Numerical simulations are performed in 3D with geometrically complex fault surfaces verifying the efficacy of the method. Our method accurately reproduces dynamic rupture benchmark problems, proposed by Southern California Earthquake Center, with less computational effort than standard methods based on traditional SBP operators.

4.11. Density estimation using quasi-Monte Carlo methods with preintegration

Speaker: Alexander Gilbert (University of New South Wales)

Time: 14:30 Wed 8 December

Place(s):

Author(s): Alexander Gilbert

Approximating the cumulative distribution function (cdf), or probability density function (pdf), of a high-dimensional random variable is a difficult task that arises in many applications, ranging from derivatives pricing in finance to computing failure probabilities in engineering. By formulating the cdf as the expected value of an indicator function of the random variable, the problem becomes one of computing a high-dimensional integral. Quasi-Monte Carlo (QMC) methods are deterministic quadrature rules that have recently achieved great success in efficiently computing high-dimensional integrals. But the success of QMC requires some level of smoothness in the integrand, which for the problem of computing a cdf is destroyed by the discontinuity caused by the indicator function. Recent work on preintegration (a.k.a. conditional sampling) showed that first integrating certain discontinuous functions with respect to a single variable results in a smoother function, but now in one dimension less.

In this talk, I will present a QMC method based on randomly shifted lattice rules and a preintegration step, to approximate the cdf of a random variable defined on $\mathbb{R}^d$. The basic idea is to use preintegration to "integrate out" the discontinuity in one dimension, and then apply a lattice rule to the remaining

$(d-1)$-dimensional function, which is now as smooth as the original random variable. By formulating the pdf as an expected value of a Dirac delta function, it can be approximated by a similar strategy. A rigorous analysis of the error shows that our cdf (and pdf) estimators achieve the same rate of convergence as using QMC to approximate the expected value only, namely, $1/N$ where N is the number of quadrature points. Finally, to illustrate the power of this method we apply it to a problem from option pricing and present numerical results.

4.12. Deep unfitted Nitsche method for elliptic interface problems

Speaker: Hailong Guo (The University of Melbourne)
Time: 17:30 Tue 7 December
Place(s):
Author(s): Hailong Guo

I will talk about a deep unfitted Nitsche method for computing elliptic interface problems with high contrasts in high dimensions. To capture discontinuities of the solution caused by interfaces, we reformulate the problem as an energy minimization involving two weakly coupled components. This enables us to train two deep neural networks to represent two components of the solution in high-dimensional. The curse of dimensionality is alleviated by using the Monte-Carlo method to discretize the unfitted Nitsche energy function. We present several numerical examples to show the performance of the proposed method.

4.13. A Simple Numerical Scheme for Reissner-Mindlin Plate Equations

Speaker: Bishnu Lamichhane (The University of Newcastle)
Time: 08:00 Wed 8 December
Place(s):
Author(s): Bishnu Lamichhane

We present a new MITC (Mixed Interpolated Tensorial Components) finite element method for Reissner–Mindlin plate equations. The new finite element method uses a biorthogonal system to construct the reduction operator for the MITC element. Numerical results demonstrate the performance of the approach.

4.14. Solving partial differential equations on spheres using neural networks

Speaker: Quoc Thong Le Gia (University of New South Wales)
Time: 14:00 Fri 10 December
Place(s):
Author(s): Quoc Thong Le Gia

Partial differential equations (PDEs) on spheres have many applications in geosciences, but finding analytical solutions to many of these PDEs can be almost impossible. In this talk, we investigate the use of machine learning techniques as numerical solvers for these PDEs with the intent of finding an efficient method which produces extensible solutions.

4.15. Compressed vector Prony analysis for supercritical Hopf bifurcations in computational fluid dynamics

Speaker: Geordie Drummond McBain (None)
Time: 13:30 Thu 9 December
Place(s):
Author(s): G. D. McBain and J. A. Edwards and S. G. Mallinson

Proper orthogonal decomposition (POD) has long been applied to simulations and measurements of statistically steady fluid flow (Berkooz, Lumley & Holmes 1993, *Ann. Rev. Fluid Mech.*). More recently it has been augmented by dynamical mode decomposition (DMD) (Schmidt 2010, *J. Fluid Mech.*) and higher order DMD (HODMD) (Vega & Le Clainche 2020, *Academic*) to extend it to evolving flows. Although the DMD ansatz of a linear operator mapping one snapshot of the system to the next cannot be universally applicable, its equivalence with decomposition into exponentials in time (Prony analysis) suggests that it might be apt for supercritical Hopf bifurcations. Here the approach is applied to a canonical example: two-dimensional viscous incompressible over a cylinder, using a simple finite element Navier–Stokes solver written in *scikit-fem* and treated as a black box.

As a preliminary step, the steady finite-amplitude oscillations of the Kàrmàn vortex street are analysed via the time-series of vorticity at a point in the near wake. Discrete Fourier transforms show that the signal largely consists of a fundamental and its harmonics, as expected, with the amplitude growing with excess of Reynolds number above the critical value but frequency only varying weakly; however, the discrete Fourier transform spreads the fundamental across several neighbouring discrete frequencies, thereby hindering the estimate of its amplitude and thus the determination of the critical point by an extrapolation of the amplitude to zero. An alternative is autoregression (AR), which is not constrained to a predetermined discrete grid of frequencies. It is also exactly what is used in Prony analysis (Prony 1795, *J. Éc. Polytech.*).

Besides the eventual stable oscillation, point-AR can be applied to the asymptotic approach to this, naturally separating the parts with negative and zero growth rate. It can also be applied below the critical point, to extract the frequency and decay rate.

These scalar time-series analyses can be extended to the whole flow field, which is then essentially HODMD, although the step from point-AR to vector autoregression (VAR) suggests that the inclusion of a constant term in the autoregression relation (absent from HODMD) might be helpful and it is indeed shown to be: whereas a constant field can be represented as a Prony mode whose growth rate happens to be zero, it is much more robust to simply include such a term and subsequently let its coefficient be zero if it is not required.

As in (HO)DMD we compress the flow-field snapshots prior to VAR using POD or singular value decomposition (SVD) (the difference being the inner product with respect to which the components are orthgonalized, viz. energy or algebraic, which differ on nonuniform finite element meshes), but here we also suggest an intermediate: POD but with the energy inner product approximated using a lumped finite element mass matrix. Since the Cholesky factorization of the diagonal lumped matrix is cheap, this costs little more than SVD while preserving most of the energy-information of full POD-based compression.

The net result of this compressed vector Prony analysis is that essentially the same information as from a linear stability analysis—the fundamental eigenvalue and eigenmode of the supercritical Hopf bifurcation—can be extracted from a sequence of snapshots from black-box simulations at nearby Reynolds numbers, either above or below the critical.

4.16. Model-free prediction of noisy, chaotic systems

Speaker: Sean McGowan (The University of Adelaide)
Time: 09:00 Wed 8 December
Place(s):
Author(s): Sean McGowan

Predicting the evolution of dynamics from a given trajectory history of an unknown system is an important and challenging problem. In practice, the simultaneous measurement of all relevant variables of a system is not possible and therefore we must rely on partial state observation. Many real systems exhibit chaotic behaviour, and this presents further complications due to the sensitivity to initial conditions inhibiting many model-based approaches to prediction. Trajectories from these chaotic systems are often complicated whereas the underlying dynamics may be simple. Additionally, the fact that data is often corrupted by noise makes prediction particularly difficult.

In this talk, a model-free method for reconstructing full system dynamics to predict chaotic systems is presented. This approach relies on Takens' theorem, which allows the underlying structure of a chaotic system to be embedded from low-dimensional partially observed data into a higher embedded space. An optimal control approach to estimating the embedded dynamics is used, from which numerical integration can be applied to predict past final time. This method will be applied to predicting several chaotic systems and the robustness to measurement noise and amount of data will be assessed.

4.17. Superconvergence effects for discontinuous Galerkin time stepping

Speaker: William McLean (University of New South Wales)
Time: 13:00 Thu 9 December
Place(s):
Author(s): William McLean

We consider discontinuous Galerkin time stepping for a parabolic PDE. Using piecewise polynomials of degree at most $r-1$ in time, with $r \geq 1$, the method is unconditionally stable and achieves an optimal convergence rate of order k^r, where k denotes the maximum time step. It has long been known that if $r \geq 2$ then the right-hand limit of the DG solution can be superconvergent of order up to k^{2r-1} at the break points. We show that the DG solution can also be superconvergent of order k^{r+1} at the right Radau quadrature points in each subinterval. A simple postprocessing step then yields a *continuous* piecewise polynomial of degree at most $r \geq 2$ that achieves the optimal convergence rate k^{r+1} uniformly in time.

4.18. Local projection stabilisation of convection dominated problems using a biorthogonal system and adaptive finite element method

Speaker: Jordan Shaw-Carmody (The University of Newcastle)
Time: 08:30 Wed 8 December
Place(s):
Author(s): Jordan Shaw-Carmody

This talk will present my numerical findings upon application of a biorthogonal system to the local projection stabilisation of the convection dominated problem. Previous research has applied the finite element method to this set of problems, but the focus here involves the use of the adaptive finite element method. We will provide the results of this approach compared to the uniform refinement approach of the finite element method. A special interest is applied to examples that contain a transition layer.

4.19. So you have shown that two function spaces are equivalent? Why does it matter? Who cares?

Speaker: Ian Sloan (University of New South Wales)
Time: 14:00 Wed 8 December
Place(s):
Author(s): Ian Sloan

In a recent paper Frances Kuo, Alec Gilbert and I proved that two particular function spaces (of functions with maybe hundreds of real variables defined on the whole Euclidean space) are equivalent. This talk gives the big picture of why this equivalence matters. The context is numerical integration, over the whole of d-dimensional Euclidean space, of functions of d variables multiplied by a weight function, the latter for example a product of standard normal Gaussian densities. On the one hand there exist (thanks to earlier work of Frances and James Nichols) methods for constructing integration rules of guaranteed quality in hundreds of dimensions. That method is for integrands that are smooth enough, in the sense of belonging to a certain Hilbert space W. But often we face integrands that are not at all smooth (eg in option pricing, or the computation of cumulative probability distributions). In that case (as proved in recent work of Griewank, Kuo, Leovey and Sloan)) the integrand can often be made smooth (in the sense of belonging to another Hilbert space H) by integrating out just one of the hundreds of variables (this is called "preintegration".) Then we can use Nichols/Kuo for the resulting integral in d-1 dimensions - but only if W and H are equivalent! This work closes that gap, so allowing the construction of practical methods for many non-smooth integrals in hundreds of dimensions.

4.20. Approximating distribution functions for solutions to partial differential equations with random coefficients using quasi-Monte Carlo methods and preintegration

Speaker: Abirami Srikumar (UNSW Sydney)
Time: 15:00 Wed 8 December
Place(s):
Author(s): Abirami Srikumar

As high-dimensional problems become increasingly prevalent in many applications, the effective evaluation of these problems within the limits of our current technology poses a great hurdle due to the exponential increase in computational cost as dimensionality increases. One class of strategies for evaluating such problems efficiently are quasi-Monte Carlo (QMC) methods.

Recently the application of quasi-Monte Carlo methods to approximate expected values associated with solutions to elliptic partial differential equations with random coefficients in uncertainty quantification has been of great interest. In this talk, we look into extending this from the computation of expected values to the approximation of distribution functions by reformulating these functions as expectations of an indicator function. However this requires the integration of discontinuous functions and hence the need for preintegration, whereby we integrate out a single variable of the discontinuous function in order to obtain a function of one dimension less with sufficient level of smoothness to apply QMC methods. We also present some results regarding the error bounds associated with such approximations.

4.21. An Extended Hybrid High-Order method for the Poisson problem with singular solutions

Speaker: Liam Yemm (Monash University)
Time: 15:00 Tue 7 December
Place(s):
Author(s): Liam Yemm

Hybrid High-Order (HHO) methods are modern numerical schemes for the discretisation of elliptic problems. However, HHO - like other high-order methods - requires high-order regularity of the exact solution to achieve optimal convergence rates. It is known that singular solutions of the Poisson problem can arise from corners in the boundary of an otherwise smooth domain. We propose here an Extended Hybrid High-Order (XHHO) scheme for the Poisson problem with solution possessing weak singularities. The method is formulated by enriching the local polynomial spaces with appropriate singular functions. Under some general assumptions on the local regularity of these functions it is shown that optimal approximation rates can be obtained.

5. Cryptography, Coding Theory and Related Topics

5.1. On a Tree Coloring Problem and Its Application in Private Data Retrieval from a Merkle Tree

Speaker: Son Hoang Dau (RMIT University)
Time: 09:00 Thu 9 December
Place(s):
Author(s): Son Hoang Dau

A Merkle tree is a binary tree in which each node is the (cryptographic) hash of the concatenation of the contents of its child nodes. A Merkle tree represents a large amount of data in a way that not only guarantees the integrity of data (any change in the content will lead to the change in the root of the tree) but also allows very efficient membership testing, which can be performed with complexity log(n) where n is the number of data items stored at the leaf nodes. Because of its simple description and powerful features, Merkle trees have been widely used in practice, e.g., for data synchronization in Amazon DynamoDB, for logs storage in Google's Certificate Transparency, and for transactions storage in blockchains. In this talk, we will report our recent findings on the problem of private data retrieval in Merkle trees, using a novel tool in tree coloring.

5.2. Math & Crypto: How CRT is Used to Solve Interesting Crypto Problems

Speaker: Muhammed Esgin (Monash University)
Time: 14:30 Wed 8 December
Place(s):
Author(s): Muhammed Esgin

There is no doubt that various mathematical results are at the core of design and analysis of cryptographic algorithms. Despite this strong relation between Mathematics and Cryptography, a strong collaboration between the researchers from the two fields is not well established. The goal of this talk is to encourage such collaborations by discussing an example case where an important mathematical result has found interesting applications in cryptography.

The talk will particularly focus on the use of Chinese Remainder Theorem (CRT) in the context of advanced cryptographic proof systems (a.k.a. "zero-knowledge proofs"). Without assuming crypto background and delving into technical details, we will discuss an important technical problem relating to these proof systems and how CRT-based recent results have been used to address the problem. The talk will be concluded by some related open questions of significant interest to cryptography and how math expertise is likely to be crucial in solving them.

5.3. Public key cryptography and lattices with a ring structure

Speaker: Jeffrey Hoffstein (Brown University)

Time: 08:00 Wed 8 December

Place(s):

Author(s): Jeffrey Hoffstein

Public key cryptosystems (PKCs) are based on hard mathematical problems. The hard problems that traditional PKCs such as RSA, Diffie-Hellman and elliptic curve variants on Diffie-Hellman are based on have all been shown to be vulnerable to sufficiently strong quantum computers. These are yet to be built, but it is reasonably probable that they will exist within 5 to 10 years. Lattices are generally viewed as good candidates to build PKCs on, as their associated hard problems (The Closest Vector Problem and the Shortest Vector Problem) appear (so far...) to be resistant to quantum computers. Lattices are generally thought of as additive objects: you can add two vectors or take a linear combination with integral coefficients. However, in 1996 I, Jill Pipher and Joe Silverman introduced a new type of lattice that had a ring structure. We used this to create a PKC called NTRU. Lattices with a ring structure have a number of advantages. I will describe these advantages, and describe, to the extent time allows, several other ring based lattices that have crypto related applications.

5.4. Classical to Post-Quantum ABE-IBE Proxy Re-Encryption Scheme

Speaker: Muhammad Nauman Khan (RMIT University)

Time: 09:00 Wed 8 December

Place(s):

Author(s): Muhammad Nauman Khan

Fast developing technologies such as the Internet of Things (IoT), smart devices and artificial intelligence (AI) have resulted in solutions such as Industrial IoT for manufacturing and energy management, smart transportation, and smart cities. These solutions often interconnect Internet-based cloud systems with IoT at scales deep inside organizations' boundaries and create computationally asymmetric systems. In response, numerous protocols with lightweight cryptographic algorithms have been developed to address the constraints on the limited resource components and to provide a sufficient level of security for resource-limited IoT devices located within organizations' boundaries. However, they are no match for the potential attacks on relatively more malicious Internet and cloud environments where more resources are available for heavier cryptographic protections and attackers. Moreover, the evolution of quantum computing adds more to those risks. We aim to fill this gap by presenting an ABE-IBE proxy re-encryption scheme to securely transform a lightweight classical ciphertext at intranet domain to lattice-based ciphertext for relatively more malicious Internet domain and vice versa. The comparison of our ABE-IBE scheme with classical proxy re-encryption scheme highlights its potential for improved security and optimized resource consumption in computationally asymmetric computations systems.

5.5. Proving Proximity to Polynomials

Speaker: Swastik Kopparty (University of Toronto)

Time: 08:00 Thu 9 December

Place(s):

Author(s): Swastik Kopparty

I will talk about some recent results on interactive protocols for proving that a given table is close to the evaluation table of a low-degree polynomial. Such protocols are useful for delegating general computation (quickly verifying that the answer of a computation outsourced to someone is correct, by asking that someone to provide additional information).

The mathematical core of these results is the following phenomenon: Let F be a field, and S be a subset of F. If two functions f,g from S to F are such that there are many z in F such that f + z g is close (in Hamming distance) to a low-degree polynomial, then BOTH f and g are close to low-degree polynomials.

Based on several joint works with Eli Ben-Sasson, Dan Carmon, Lior Goldberg, Yuval Ishai, David Levit and Shubhangi Saraf

5.6. Finding shortest and closest vectors in a lattice of Voronoi's first kind

Speaker: Robby McKilliam (Myriota)

Time: 15:00 Wed 8 December

Place(s):

Author(s): Robby McKilliam

Two fundamental computational problems in number theory are the shortest lattice point problem and the closest lattice point problem. The shortest lattice point problem has interested mathematicians and computer scientists due to its relationship with integer programming, the factoring of polynomials, and cryptanalysis. The closest lattice point problem has engineering applications such as coding, quantisation, data compression, multi-antennae communication, phase unwrapping, single frequency estimation, and related signal processing applications. Both problems are known to be NP-hard in general, that is, for "arbitrary" lattices. However, there can exist fast algorithms for specific lattices. In 2014 we discovered faster algorithms for the specific family of lattices of Voronoi's first kind. Each lattice in this family has what is called an obtuse superbasis. If the obtuse superbasis is known then a short vector can be computed in $O(n^3)$ operations and a closest point in $O(n^4)$ operations where n is the dimension of the lattice. Both algorithms rely on efficient procedures for computing a minimum cut in an undirected flow network. We describe these results and some recent extensions to the larger class of zonotopal lattices by Vallentin, et. al.

5.7. DRS Factorization Method

Speaker: Anthony Overmars (None)

Time: 14:00 Thu 9 December

Place(s):

Author(s): Anthony Overmars

Knuth [1] stated that attempting to factorize a semi-prime, $N = PQ$ with $kN4$ "is a rather curious way to proceed, if not DownRight Stupid" (DRS). Schroeppel [2] suggested k was essentially the expected value of the logarithm of $\frac{\sqrt{N}}{T}$. Hart's [3] one line factorization, exploits kN using Fermat.

$$x^2 = y^2 \mod N \implies x^2 - y^2 = kN = (x-y)(x+y).P = gcd(x-y, N), Q = gcd(x+y, N).$$

We show that the convergences of the continued fraction $\frac{P}{Q}$ leads to suitable values of k which can then be applied to Hart's one line factorization method. This is applied to all known RSA challenge numbers, whose continued fraction convergences, lead to factorization. This is of course a chicken and egg, hence DRS. However, despite Knuth's DRS assertion, this paper provides new insights into the values of k. A simple algorithm using rational numbers is presented which finds the smallest convergence $\frac{p}{q}$ value for k (P, Q unknown), resulting in factorization. Some performance measures are provided.

5.8. Revisiting signature schemes based on isomorphism problems

Speaker: Youming Qiao (University of Technology Sydney)

Time: 14:00 Wed 8 December

Place(s):

Author(s): Youming Qiao

We study a signature scheme based on the alternating trilinearform equivalence problem, the Goldreich-Micali-Wigderson zero-knowledge protocol for graph isomorphism (J. ACM 1991), and the Fiat-Shamir transformation (CRYPTO 1986). First, we present theoretical evidence to support its security, especially in the post-quantum cryptography context. The evidence is drawn from several research lines, including hidden subgroup problems, multivariate cryptography, cryptography based on group actions, the quantum random oracle model, and recent advances on isomorphism problems for algebraic structures in algorithms and complexity. Second, we demonstrate its potential for practical uses. Based on algorithm studies, we propose concrete parameter choices, and then implement a prototype whose performance is promising for practical uses.

Based on a joint work with Gang Tang, Dung Hoang Duong, Thomas Plantard, and Willy Susilo.

5.9. Computational Problems from Combinatorics and Algebra

Speaker: Travis Scrimshaw (Osaka City University)

Time: 16:00 Wed 8 December

Place(s):

Author(s): Travis Scrimshaw

The field of combinatorial optimization is generally about problems involving graphs, which includes the famous traveling salesman problem. However, the broader fields of combinatorics and algebra have many additional structures that appear to be difficult to compute, even if the process is well-adapted for a computer to do. As such, they could be fertile ground for developing new cryptographic schemes. I only say appears because very little explicit complexity analysis seems have been undertaken. In this talk, we will survey some objects I believe are computationally difficult, where showing that they are not secure will lead to new interactions between these fields.

5.10. Redactable blockchains

Speaker: Vladimir Shpilrain (City University of New York)

Time: 16:30 Wed 8 December

Place(s):

Author(s): Vladimir Shpilrain

A blockchain is redactable if a private key holder (e.g. a central authority) can change any single block without violating integrity of the whole blockchain, but no other party can do that. The need for a blockchain (even a public one!) to be redactable is well explained by the following quote from The New York Times: "That permanence has been vital in building trust in the decentralized currencies, which are used by millions of people. But it could severely limit blockchain's usefulness in other areas of financial services relied on by billions of people. By clashing with new privacy laws like the "right to be forgotten" and by making it nearly impossible to resolve human error and mischief efficiently, the blockchain's immutability could end up being its own worst enemy."

Eliminating redundancies and deleting outdated records is especially vital for networks (such as the Internet of Things) of small devices. We are going to describe a very simple yet provably secure construction of redactable blockchains. This is based on joint work with Dima Grigoriev.

5.11. Threshold Ed25519 Digital Signatures

Speaker: Matthew Paul Skerritt (RMIT University)

Time: 13:30 Thu 9 December

Place(s):

Author(s): Matthew P. Skerritt

Threshold digital signature schemes allow a single signature to be calculated in a distributed fashion from multiple signatures. Such schemes can (but are not required to) be combined with Shamir secret sharing for the underlying private key, hence the "threshold" term in the name.

A commonly used and well regarded elliptic curve digital signature scheme is Ed25519 (a particular instance of the more general EdDSA scheme). Ed25519 is closely related to the Curve25519 scheme used for Diffie–Hellman style key exchange, and incorporates several protections against common attacks. These protections complicate the use of Ed25519 for threshold signatures.

We will outline the Ed25519 digital signature scheme and discuss the implications for threshold computation (including the current state of standardisation drafts). We will also introduce and outline a distributed cryptosystem proposed by TIDE for threshold Ed25519 using Shamir Secret Sharing. We compare and contrast the TIDE system against the current standardisation drafts.

Research Project with Dr. Joanne L. Hall and Dr. Geetika Verma of RMIT and Yuval Hertzog, Jose Luis Lobo, and Dominique Valladolid of TIDE Foundation.

5.12. Swarm Randon Number Generator for use in secret sharing

Speaker: Geetika Verma (RMIT University)

Time: 13:00 Thu 9 December

Place(s):

Author(s): Geetika Verma

Most cryptographic systems, and therefore most cybersecurity systems, rely on random number generation (RNG). Sequences of numbers which can not be predicted are used as secret keys, or to seed a Pseudo RNG. We introduce a Swarm random number generator (RNG), which takes advantage of Shamir Secret Sharing to distribute the random number generation across multiple independent machines. The use of secret sharing ensures that none of the individual machines, nor any of the network traffic ever have sufficient information to reconstruct the secret random number. The swarm RNG has high entropy, even if many of the individual machines have low entropy RNG which improves resilience in the system. Research Project with Dr. Joanne Hall and Dr. Matt. P. Skerritt of RMIT and Yuval Hertzog, Jose Luis Lobo, and Dominique Valladolid of TIDE Foundation.

5.13. Locally recoverable codes and algebraic surfaces

Speaker: Felipe Voloch (University of Canterbury)

Time: 08:30 Thu 9 December

Place(s):

Author(s): Felipe Voloch

An error correcting code is a subspace of F^n, where F is a finite field. Such a code is said to be locally recoverable with locality r if, for every coordinate of a codeword, its value can be deduced from the value of (certain) r other coordinates. These codes have found many recent applications, e.g., to cloud storage. We will construct good locally recoverable codes using algebraic surfaces.

6. Dynamical Systems and Ergodic Theory

6.1. Non-Stationary Patterns in a three-component FitzHugh-Nagumo System

Speaker: Claudio Arancibia-Ibarra (Queensland University of Technology)

Time: 16:00 Tue 7 December

Place(s):

Author(s): Claudio Arancibia-Ibarra

In this work, we study a planar three-component FitzHugh-Nagumo model. By using geometric singular perturbation theory, we show the existence of radially symmetric stationary and non-stationary ring solutions. In particular, we focus on dynamically evolving N-front solutions and N coupled ODEs that governs the positions of the fronts. We use numerical simulations to illustrate the dynamics of the N-front solutions.

6.2. Stability of Dynamical Systems and Lyapunov-like Characterizations

Speaker: Philipp Braun (Australian National University)

Time: 14:30 Tue 7 December

Place(s):

Author(s): Philipp Braun

The fundamental theory that emerged from Aleksandr Mikhailovich Lyapunov's doctoral thesis more than 100 years ago, has been and still is the main tool to analyze stability properties of dynamical systems. Lyapunov or Lyapunov-like functions are monotone functions when evaluated along the solution of a dynamical system. Based on the monotonicity property, stability of invariant sets can be concluded without the need to derive explicit solutions of the system dynamics.

Motivated through the recent monograph "(In-)Stability of differential inclusions: Notions, Equivalences, and Lyapunov-like Characterizations" (by P. Braun, L. Grüne and C. M. Kellett), in this talk, we highlight various results on Lyapunov functions and their versatility and applicability in the context of ordinary differential equations, difference equations, differential inclusions, hybrid systems and control systems.

6.3. Reconstructing a minimal topological dynamical system from a set of return times

Speaker: Kamil Bulinski (The University of Sydney)

Time: 08:30 Thu 9 December

Place(s):

Author(s): Kamil Bulinski

I will present a joint work with Sasha Fish (University of Sydney) where we investigate to what extent a minimal topological dynamical system is uniquely determined by a set of return times to some open set. We show that in many situations this is indeed the case as long as the closure of this open set has no non-trivial translational symmetries. For instance, we show that under this assumption two Kronecker systems with the same set of return times must be isomorphic. More generally, we show that if a minimal dynamical system has a set of return times that coincides with a set of return times to some open set in a Kronecker system with translationarily asymmetric closure, then that Kronecker system must be a factor. We also study similar problems involving Nilsystems and polynomial return times. We state a number of questions on whether these results extend to other homogeneous spaces and transitive group actions, some of which are already interesting for finite groups.

6.4. Applying the Maslov index to the Nonlinear Schrodinger equation

Speaker: Mitch Curran (The University of Sydney)

Time: 09:00 Wed 8 December

Place(s):

Author(s): Mitch Curran

The Maslov index is a hammer with which we hit the stability problem for standing waves of the Nonlinear Schrodinger equation on a compact interval. More precisely, it can be thought of as a winding number for a path of Lagrangian subspaces of a real symplectic vector space, and its applications are numerous: it can been used to generalise Sturm-Liouville theory to systems of ODEs, and appears in so-called Morse-Maslov theorems, where a count of the negative eigenvalues of a (typically selfadjoint) differential operator is given in terms of the Maslov index of an appropriate Lagrangian path. The interesting aspect of this problem is a failure of the usual properties of regularity and monotonicity in general. We prove a sharpening of the Jones-Grillakis (in)stability index for the standing waves considered. Analysis of the irregular case leads to a sign condition that resembles the Vakhitov-Kolokov criterion on the real line.

6.5. Sets of transfer times with small densities

Speaker: Alexander Fish (The University of Sydney)

Time: 13:30 Thu 9 December

Place(s):

Author(s): Alexander Fish

Given an ergodic system (X, μ, T) and measurable sets A, B of positive measures, the set of transfer times from A to B is defined as $R_{A,B} = \{n \mid \mu(A \cap T^{-n}B) > 0\}$. It is an easy consequence of the mean ergodic theorem that the lower density of $R_{A,B}$ is greater or equal than the maximum of the measures $\mu(A), \mu(B)$. We will show that in the case that the density of $R_{A,B}$ is sufficiently small in terms of $\mu(A), \mu(B)$, then $R_{A,B}$ is a periodic set. For instance, if the density of $R_{A,A}$ is strictly smaller than $3/2$ times $\mu(A)$, then there exists $k \geq 1$ such that $R_{A,A} = k\mathbb{Z}$. Joint work with Michael Bjorklund (Chalmers) and Ilya Shkredov (Russian Academy of Sciences).

6.6. Linear Stability of Periodic Trajectories in Inverse Magnetic Billiards

Speaker: Sean Gasiorek (The University of Sydney)

Time: 08:30 Wed 8 December

Place(s):

Author(s): Sean Gasiorek

We study the stability of periodic trajectories of planar inverse magnetic billiards, a dynamical system whose trajectories are straight lines inside a connected planar domain Ω and circular arcs outside Ω. Explicit examples are calculated in circles, ellipses, and the one parameter family of curves $x^{2k}+y^{2k} = 1$. Comparisons are made to the linear stability of periodic billiard and magnetic billiard trajectories.

6.7. Quenched results for random open and closed dynamical systems

Speaker: Cecilia Gonzalez-Tokman (The University of Queensland)

Time: 14:00 Thu 9 December

Place(s):

Author(s): Cecilia Gonzalez-Tokman

We will present recent results on ergodic properties and thermodynamic formalism for random open and closed dynamical systems. The focus will be on the so-called quenched perspective, which aims at describing the behaviour of the system for fixed realisations of the environment. (Joint work with Jason Atnip, Gary Froyland and Sandro Vaienti).

6.8. Ergodicity and accessibility in dimension 3

Speaker: Andy Hammerlindl (Monash University)
Time: 14:30 Thu 9 December
Place(s):
Author(s): Andy Hammerlindl

The Pugh-Shub conjectures have been a major motivation for recent research into partially hyperbolic dynamics. Roughly speaking, these conjectures state that most volume preserving partially hyperbolic systems are stably ergodic and that accessibility is the key tool for establishing this. The Pugh-Shub conjectures have been proven for systems in dimension 3, and this leads to the question of exactly which systems in dimension 3 are accessible. In my talk, I will discuss progress on answering this question.

6.9. On the stability of isothermal shocks in black hole accretion disks

Speaker: Eric William Hester (University of California Los Angeles)
Time: 09:00 Thu 9 December
Place(s):
Author(s): Eric William Hester

Most black holes possess accretion disks. Models of such disks inform observations and constrain the properties of the black holes and their surrounding medium. Here, we study isothermal shocks in thin black hole accretion flows. Infinitesimal molecular viscosity motivates the use of multiple-scales matched asymptotic methods. Geometric singular perturbation theory validates our analysis. We thus derive the first explicit calculations of isothermal shock stability. We find that the inner shock is always unstable, and the outer shock is always stable. The growth/decay rates of perturbations depend only on an effective potential and the velocity jump at the shock location. We then give a prescription of accretion regimes in terms of angular momentum and black hole radius. Accounting for angular momentum dissipation implies unstable outer shocks in much of parameter space, even for realistic viscous Reynolds number of the order $\approx 10^{20}$.

6.10. Configurations in trees of positive dimension

Speaker: Leo Jiang (University of Toronto)
Time: 15:00 Tue 7 December
Place(s):
Author(s): Leo Jiang

In 2003, Furstenberg and Weiss proved a multiple recurrence theorem for some Markov processes related to fractal geometry. They used this result to obtain analogues of Szemerédi's theorem for trees. Following their setup, we obtain lower bounds on the abundance of certain configurations in trees of positive dimension. Further, we prove inverse-type results by an analysis of sets of return times, with input from additive combinatorics. This is joint work with Alexander Fish and Ilya D. Shkredov.

6.11. The geometry of a blender: the case of spaghetti in a can

Speaker: Bernd Krauskopf (University of Auckland)
Time: 08:00 Thu 9 December
Place(s):
Author(s): Bernd Krauskopf

Blenders are a geometric tool to construct robust recurring dynamics in a theoretical setting; one also speaks of wild chaos. We consider an explicit family of 3D Hénon-like maps and show that it exhibits a blender for a specific parameter range where the underlying 2D Hénon map has a full horseshoe. The blender arises as the closure of the one-dimensional stable manifolds of two saddle points, which weave such a complicated pattern in space that these curves form an impenetrable carpet when seen from certain directions. We combine advanced numerical techniques with the compactification of phase space to compute extremely long pieces of the two global invariant manifolds, which allows us to determine when they form a blender and when not. In a nutshell, we study the geometry of infinitely long spaghetti in a can.

This is joint work with Dana C Julio and Hinke Osinga.

6.12. Periodic solutions of a theta neuron subject to delayed self-feedback

Speaker: Carlo Laing (Massey University)

Time: 13:00 Thu 9 December

Place(s):

Author(s): Carlo Laing

We consider a single theta neuron with delayed self-feedback in the form of a Dirac delta function in time. Because the dynamics of an uncoupled neuron can be solved explicitly we can derive algebraic expressions for the existence and stability of periodic solutions. We can also give explicit expressions for the location in parameter space of saddle-node bifurcations of these orbits, giving a complete description of these types of solution. The generic nature of the model means that our results give a basis for understanding similar dynamics observed in other excitable systems subject to delayed self-coupling.

6.13. Phase resetting as a two-point boundary value problem

Speaker: Hinke Osinga (The University of Auckland)

Time: 08:00 Wed 8 December

Place(s):

Author(s): Hinke Osinga

Phase resetting is used in experiments with the aim to classify and characterise different neurons by their responses to perturbations away from a periodic bursting pattern. The same approach can also be applied numerically to a mathematical model. Resetting is closely related to the concept of isochrons of a periodic orbit, which are the submanifolds in its basin of attraction of all points that converge to this periodic orbit with a specific phase. Until recently, such numerical phase resets were performed in an ad-hoc fashion, and the development of suitable computational techniques was only started in the last decade or so. We present an approach based on the continuation of solutions to a two-point boundary value problem that directly evaluates the phase associated with the isochron that the perturbed point is located on. We illustrate this method with the FitzHugh–Nagumo model and investigate how the resetting behaviour is affected by phase sensitivity in the system.

This is joint work with Bernd Krauskopf (University of Auckland) and Peter Langfield (University of Bordeaux)

6.14. A combinatorial model for the dynamics of birational maps over finite fields

Speaker: John Roberts (University of New South Wales)

Time: 15:00 Thu 9 December

Place(s):

Author(s): John Roberts

In the development of Pollard's integer factorization algorithm, the action of polynomials over finite fields is approximated by assuming, on average, it is modelled by a random mapping which then implies exploitable statistical behaviours. In previous work, we showed that a random permutation well approximates the expected dynamics of a "generic" polynomial automorphism over d-dimensional affine space, when reduced modulo a prime. Here, we extend this investigation to the expected dynamics of a birational map where a new dynamical feature is the singularities arising from denominators. We propose a combinatorial model and derive its expected statistical properties and compare these to actual experiments on birational maps. The broader aim of this work is to find the signature over finite fields of various dynamical properties of birational maps. The model presented here gives the background signature before other dynamical structures are imposed, which will have their own different combinatorial models. This is joint work with Tim Siu (UNSW).

6.15. Linear response in higher dimensions and mixing of Cantor sets

Speaker: Caroline Wormell (CNRS)

Time: 16:30 Tue 7 December

Place(s):

Author(s): Caroline Wormell

Chaotic dynamical systems are typically endowed with physically meaningful ergodic measures that encode their long-term statistical behaviour. Intuitively, one expects that these measures vary differentiably (have a linear response) when the systems are smoothly perturbed. While some simple systems fail to have a linear response, it is believed that systems in high dimensions always will, a claim which does not follow from existing theory.

We study this problem through a tractable toy model of non-hyperbolicity, that of piecewise hyperbolic maps. We show, rigorously, that linear response formally obtains if a certain novel mixing property holds: that infinitesimal slices of the physical measure quickly "regenerate" the full measure when pushed forward under the flow. We present strong numerical evidence indicating that this latter property holds generically. As well as being of its own interest this property may be instrumental in proving linear response for general sets of systems.

7. Education Afternoon

7.1. A Quick and Easy Introduction to Classroom Data Science

Speaker: Linda McIver (Australian Data Science Education Institute)

Time: 16:30 Wed 8 December

Place(s):

Author(s): Linda McIver

Dr Linda McIver will give you classroom Data Science activities that are ready to use, plus amazing examples of Data Science that are changing the world, and the tools to design your own Data Science Projects, using everything from blocks to spreadsheets. Data Science made easy!

7.2. Spaced Learning

Speaker: Cassandra Portelli (Hunter School of Performing Arts)

Time: 15:00 Wed 8 December

Place(s):

Author(s): Cassandra Portelli

Spaced Learning might just be the key to having more fun with Mathematics in the classroom.

By enabling teachers to effectively cover large amounts of content in a very short amount of time, Spaced Learning may be part of a solution to our crowded curriculum, lend itself to introducing integrated STEM initiatives and cross-curricular investigations, or simply give teachers back the time they need to improve student problem solving skills and build real connections within and beyond the syllabus.

7.3. Do the Same, Do the Opposite: An Intro to the Physical-Conceptual Connection

Speaker: Erik Stern (Weber State University)

Time: 14:00 Wed 8 December

Place(s):

Author(s): Erik Stern

A virtual, participatory introduction to embodied mathematics and movement methods. Based on decades of collaborative research and implementation, Erik Stern will provide an overview the process of engaging students in creative physical problem solving as a path to mathematics learning, while also improving attitudes toward mathematics through intentional use of the body. These "arts integration" lessons put into practice what Stoltz (2015) advocates: to "locate the body as the focal point in the production of the lived experience, and also recognise the role corporeal movement and embodiment plays in learning". By tasking each participant to explore their own level of physical abilities and interests, these activities are accessible to any person. The workshop focuses on the warm up portion of a lesson and gives examples of how it can be extended to concepts for secondary students: number lines, positive and negative numbers, and symmetry.

[1] Steven A. Stolz. (2015). Embodied Learning, Educational Philosophy and Theory, 47:5, 474–487.

Key words: arts integration; embodied learning; kinesthetic; math anxiety; creative choice and agency.

7.4. Beyond the Compass: Geometric Constructions with Circle Templates

Speaker: Chris Tisdell (University of New South Wales)
Time: 16:00 Wed 8 December
Place(s):
Author(s): Chris Tisdell

For thousands of years, the compass and straightedge have dominated the learning and teaching of geometry. As such, these inherited long-standing ways of thinking and working have gained a lustre of naturalized pedagogical value. However, mounting evidence suggests that many learners and teachers struggle to efficiently, effectively and safely use compasses when constructing geometric figures. Thus, there is a need to reconsider the role of the compass and to offer alternatives. The purpose of this presentation is to explore the aforementioned need, and to ultimately establish a foundation of practical geometric methods involving alternative instruments that are safe, efficient and effective. The scope of ideas includes well-known constructions, such as: bisecting a given line segment, constructing a parallel line through a given point, constructing a perpendicular line through a given point, determining the centre of a given circle and so on. These constructions are seen in the Stage 4 curriculum within NSW schools.

8. Equity, Diversity and Inclusivity in Mathematics

8.1. Designing mathematics outreach workshops for operational versatility

Speaker: Yudhistira Andersen Bunjamin (UNSW Sydney)
Time: 15:00 Thu 9 December
Place(s):
Author(s): Jason Atnip, Yudhistira A. Bunjamin, Sean Gardiner

In June 2021, the School of Mathematics and Statistics at UNSW Sydney held its annual Girls Do The Maths day after a year of absence due to the pandemic. This year's event consisted of an in-person event but with a limited capacity as well as an additional online event the following week.

This year, we also trialled having interactive workshops as part of the day's activities for the first time. There were three workshops run during the face-to-face event, one of which was newly designed especially for the event, and one new workshop for the inaugural Girls Do The Maths online event.

The unusual circumstances that the workshops had to be run under such as strict COVID-safety measures in the face-to-face event presented many operational challenges. The existing workshops required some adaptation to run under circumstances that they were not designed for. On the other hand, the newly designed workshops had to be designed with a greater emphasis on operational versatility.

This talk presents some of the operational challenges that arose from these unusual circumstances and their direct impact on our usual equity considerations as well as the mathematical and pedagogical value of the workshops.

The talk "Visual design of an outreach workshop based on bijections" by Sean Gardiner in the Visualisation and Mathematical Art special session will discuss the outreach workshop that was newly designed for the in-person event.

8.2. Gender differences in the skills sought when recruiting for graduate roles

Speaker: Joanne Hall (Royal Melbourne Institute of Technology)
Time: 14:30 Thu 9 December
Place(s):
Author(s): Joanne Hall and Asha Rao

There is mounting evidence of bias in recruitment of STEM roles based on the gender of the person seeking to be hired. We examine the possibility of bias in recruitment based on the gender of those making hiring decisions. Our focus is on the gender differences in the skills sought during cybersecurity graduate recruitment.

Transitioning from academic studies into the workforce is a challenge. To support industry ready curriculum design we investigated the non-technical skills that employers are seeking when recruiting into graduate cybersecurity positions. We ran an online survey of Australian cyber security professionals to determine the most sought after non-technical skills. Our analysis showed distinct gender differences in the non-technical skills most valued. The gender differences in our data are not explained by the higher proportion of women in non-technical cybersecurity roles, indicating that gender is an important factor.

Our analysis highlights the importance of gender diversity in decision makers in recruitment for graduate cybersecurity positions.

9. Geometry with Symmetries

9.1. Recent developments in the curvature of Hermitian manifolds

Speaker: Kyle Broder (The Australian National University)

Time: 16:00 Tue 7 December

Place(s):

Author(s): Kyle Broder

Within complex geometry, the complex manifolds which support a Kähler structure are best understood. The curvature of a Kähler metric has the symmetries of the Riemannian curvature tensor, and the Riemannian techniques, therefore, can often be extended to this setting. For the curvature of an arbitrary Hermitian metric, however, this is violently false and the situation is much more complicated. Within the last few months, there has been some improvement in our understanding of such curvatures, and this is what I will give some indication of.

9.2. SU(2)-invariant steady Ricci solitons on cohomogeneity one four-manifolds

Speaker: Timothy Buttsworth (The University of Queensland)

Time: 15:00 Tue 7 December

Place(s):

Author(s): Timothy Buttsworth

A number of important complete steady Ricci solitons have been constructed on non-compact four-manifolds that are invariant under a $U(2)$ action. These include the Taub-NUT, Taub-Bolt and Eguchi-Hanson metrics which are all Ricci-flat, as well as a recent construction of a non-collapsed soliton by Appleton, which is not Ricci-flat. In this talk, we will examine these steady solitons, and discuss the possibility of finding new steady solitons that are merely $SU(2)$-invariant, instead of invariant under the large group $U(2)$.

9.3. Blowing up Sequences of Constant Mean Curvature Tori in Euclidean 3-Space to Yield Minimal Surfaces

Speaker: Emma Carberry (The University of Sydney)

Time: 15:00 Thu 9 December

Place(s):

Author(s): Emma Carberry

I will consider sequences of constant mean curvature (cmc) immersions f_n of tori into $\mathbb{R}^3$ and explain under what circumstances a "blow up" (i.e. a rescaling of both the parameter for f_n and that of the ambient Euclidean space) produces a sub-sequence whose limit is a minimal surface immersion. These surfaces are studied via the sinh-Gordon and KdV integrable systems respectively. In particular, certain optimally fast blow ups of cmc tori yield helicoids.

9.4. Symmetric and asymmetric ancient mean curvature flows

Speaker: Mat Langford (The University of Newcastle)
Time: 16:00 Wed 8 December
Place(s):
Author(s): Mat Langford

Ancient solutions to geometric flows are expected to be highly rigid and symmetric, as diffusion has had an infinite time to "sort things out".

We present recent progress on the classification of ancient mean curvature flows which demonstrates that this expectation is indeed justified in certain cases, but not in others.

In particular, there is a class of convex ancient mean curvature flows which is parametrized by the circumscribed convex bodies in one dimension lower (a very large and flexible class). These examples necessarily admit a reflection symmetry, but generically admit no further ambient symmetries. On the other hand, the unique rotational example (used as a barrier) is crucial in their construction and classification.

This is joint work with Theodora Bourni and Giuseppe Tinaglia.

9.5. The secondary characteristic classes of singular foliations

Speaker: Benjamin Blake McMillan (The University of Adelaide)
Time: 16:30 Wed 8 December
Place(s):
Author(s): Benjamin Blake McMillan

One of the central tools in the global theory of regular foliations are the secondary characteristic classes. There are two classical approaches to defining them, the Chern-Weil style construction due to Bott—using the curvature of an adapted connection—and the classifying space construction of Haefliger. The latter approach quickly demonstrates the formal properties of the secondary characteristic classes, while the former provides explicit differential form representatives. In joint work with Lachlan Macdonald, we extend Bott's construction to Haefliger-singular foliations. I will explain our results, as well how they open up new methods for constructing foliations with interesting characteristic classes.

9.6. Einstein hypersurfaces in irreducible symmetric spaces

Speaker: Yuri Nikolayevsky (La Trobe University)
Time: 15:00 Wed 8 December
Place(s):
Author(s): Yuri Nikolayevsky

We classify Einstein hypersurfaces M in irreducible symmetric spaces $\overline{M}$ of rank greater than 1 (the classification in the rank-one case was previously known). We show that either $\overline{M}$ is of noncompact type, and M is a codimension one Einstein solvmanifold, or $\overline{M} = \mathrm{SL}(3)/\mathrm{SO}(3)$ (respectively $\mathrm{SU}(3)/\mathrm{SO}(3)$), and M is a hypersurface of conullity 2 with totally geodesic leaves of constant Gauss curvature whose "directrix" is a proper affine sphere in $\mathbb{R}^3$ (respectively, a special Legendrian surface in S^5).

This is a joint work with JeongHyeong Park (Sungkyunkwan University, Korea)

9.7. New Curvature Conditions for the Bochner Technique

Speaker: Peter Petersen (University of California Los Angeles)
Time: 14:00 Wed 8 December
Place(s):
Author(s): Peter Petersen

The talk will cover recent joint work of Matthias Wink and my self. The focus is on the Bochner Technique. This technique relates lower curvature bounds to the Betti numbers of the manifold both for general manifolds and for more special spaces such as Kähler manifolds. We will give a brief overview of the known classical results and some of the stronger related theorems that have come out of using the Ricci flow. Finally we will explain our new curvature assumptions, their relationship to Betti numbers, and how they diverge from curvature conditions that work well with the Ricci flow.

9.8. Mountain pass approach to the prescribed Ricci curvature problem

Speaker: Artem Pulemotov (The University of Queensland)

Time: 14:30 Tue 7 December

Place(s):

Author(s): Artem Pulemotov

We will discuss new results for the prescribed Ricci curvature problem on homogeneous spaces based on mountain pass techniques. Joint work with Wolfgang Ziller (University of Pennsylvania).

9.9. CR embeddings of CR manifolds with complex infinitesimal symmetries

Speaker: Gerd Schmalz (University of New England)

Time: 14:30 Thu 9 December

Place(s):

Author(s): Michael Cowling, Masoud Ganji, Alessandro Ottazzi, Gerd Schmalz

A CR-manifold is a hybrid of a real and a complex manifold, where the Cauchy-Riemann equations only make sense in certain directions. Examples of CR manifolds are real hypersurfaces, or more generally, real submanifolds of the complex space. Abstract CR structures on a $2n+k$-dimensional manifold M can be given by specifying a $2n$-dimensional subbundle D of the tangent bundle and a smooth field of linear endomorphisms J on D such that $J^2 = -id$. It is a fundamental question when such abstract CR manifold can be (locally) realised as a submanifold of C^N. This can be expressed as solubility of a system of PDE. For $k = 0$ this question is answered by the classical Newlander-Nirenberg theorem. The Kuranishi-Webster theorem deals with the case $k = 1$, $n > 2$. The case $n = 1$ is notoriously difficult. In his thesis, Masoud obtained an interesting result that relates realisability to the existence of certain 4-dimensional space times. I will talk about a recent result with Cowling, Ottazzi (UNSW) and Masoud that establishes realisability if there exist complex vector fields whose commutators are in a sense close to the commutators of a (finite-dimensional) Lie algebra. This generalises a result by Hill and Nacinovich for solvable Lie algebras.

9.10. Positive Hermitian curvature flow on nilpotent and almost-abelian complex Lie groups

Speaker: James Stanfield (None)

Time: 16:30 Tue 7 December

Place(s):

Author(s): James Stanfield

The success of the (Kähler)-Ricci flow sparks a natural desire to seek suitable generalisations to non-Kähler Hermitian geometry. In this presentation, we will focus on one such generalisation. Namely, the Positive Hermitian Curvature Flow introduced by Ustinovskiy as part of a family of Hermitian Curvature Flows originally studied by Streets and Tian. This evolution equation is of interest as it preserves many natural curvature positivity conditions for Hermitian manifolds.

We consider the Positive Hermitian Curvature Flow on the space of left-invariant Hermitian metrics on a complex Lie group G, a large class of Hermitian manifolds which are typically non-Kähler. Specifically, we will study the asymptotic behaviour when G is nilpotent or almost-abelian. Time permitting, we will also discuss results regarding soliton solutions in these settings and the case where G is simple.

9.11. Examples of Ricci limit spaces with non-integer Hausdorff dimension

Speaker: Guofang Wei (University of California, Santa Barbara)

Time: 13:00 Thu 9 December

Place(s):

Author(s): Jiayin Pan and Guofang Wei

We give the first examples of collapsing Ricci limit spaces on which the Hausdorff dimension of the singular set exceeds that of the regular set; moreover, the Hausdorff dimension of these spaces can be non-integers. This answers a question of Cheeger-Colding about collapsing Ricci limit spaces.

9.12. Curve diffusion and free elastic flows on parallel lines

Speaker: Valentina-Mira Wheeler (University of Wollongong)
Time: 17:00 Tue 7 December
Place(s):
Author(s): Valentina-Mira Wheeler

In this talk I discuss some convergence results for the curve diffusion and free elastic flows with free boundary. The outline is as follows: (1) Introduction to the problem and key challenges; (2) A-priori estimates independent of initial data; (3) Global analysis under a curvature condition; and (4) Convergence, conjectures and some open questions. This is joint work with Glen Wheeler (UOW).

9.13. A numerical stability analysis of mean curvature flow of noncompact hypersurfaces with Type-II curvature blowup

Speaker: Haotian Wu (The University of Sydney)
Time: 17:30 Tue 7 December
Place(s):
Author(s): Haotian Wu

We present a numerical study of the local stability of mean curvature flow of rotationally symmetric, complete noncompact hypersurfaces with Type-II curvature blowup. This is based on joint work with David Garfinkle, James Isenberg and Dan Knopf.

9.14. Min-max theory for capillary surfaces

Speaker: Jonathan Julian Zhu (Australian National University)
Time: 14:00 Thu 9 December
Place(s):
Author(s): Jonathan Julian Zhu

We develop a min-max theory for the construction of capillary surfaces in 3-manifolds with smooth boundary. In particular, for a generic set of ambient metrics, we prove the existence of nontrivial, smooth, almost properly embedded surfaces with any given constant mean curvature c, and with smooth boundary contacting at any given constant angle θ.

10. Geometric and Harmonic Analysis

10.1. Regularized inverse Brascamp-Lieb inequalities

Speaker: Neal Bez (Saitama University)
Time: 18:30 Wed 8 December
Place(s):
Author(s): Neal Bez

For the inverse Brascamp-Lieb inequality, Barthe and Wolff used mass transportation techniques to prove that gaussian near-minimizers always exist, thus establishing a counterpart to Lieb's famous theorem on gaussian near-maximizers for the forward Brascamp-Lieb inequality. Here we discuss some joint work with Shohei Nakamura on the inverse Brascamp-Lieb inequality for certain regularized input functions, in particular providing an alternative approach to the Barthe-Wolff result based on heat flow.

10.2. The stickiness property of nonlocal minimal surfaces

Speaker: Serena Dipierro (The University of Western Australia)
Time: 16:30 Fri 10 December
Place(s):
Author(s): Serena Dipierro

In this talk, we will discuss some recent results related to the boundary behavior of nonlocal minimal surfaces, that are surfaces which minimise a fractional perimeter functional. In particular, we will present the so-called stickiness phenomenon, namely the tendency of these objects to stick at the boundary of the reference domain, also in the setting of antisymmetric boundary data.

10.3. Functional Calculus via the extension technique: a first hitting time approach

Speaker: Daniel Hauer (The University of Sydney)

Time: 17:00 Fri 10 December

Place(s):

Author(s): Daniel Hauer

In this article, we present a solution to the problem:

Which type of linear operators can be realized by the Dirichlet-to-Neumann operator associated with the operator $-\Delta - a(z)\frac{\partial^2}{\partial z^2}$ on an extension problem?

which was raised in the pioneering work [Comm. Par.Diff. Equ. 32 (2007)] by Caffarelli and Silvestre. In fact, we even go a step further by replacing the negative Laplace operator $-\Delta$ on $\mathbb{R}^d$ by an m-accretive operator A on a general Banach space X and the Dirichlet-to-Neumann operator by the Dirichlet-to-Wentzell operator. We establish the uniqueness of solutions to the extension problem in this general framework, which seems to be new in the literature and of independent interest. The aim of this paper is to provide a new Phillips-Bochner type functional calculus that uses probabilistic tools from excursion theory. With our method, we are able to characterize all linear operators $\psi(A)$ among the class $\mathcal{CBF}$ of complete Bernstein functions ψ, resulting in a new characterization of the famous *Phillips' subordination theorem* within this class $\mathcal{CBF}$.

10.4. Clifford translation and bandpass bases

Speaker: Jeffrey Hogan (The University of Newcastle)

Time: 17:30 Fri 10 December

Place(s):

Author(s): Jeffrey Hogan

We investigate the application of Clifford translation and modulation to the construction of bandpass bases consisting of functions whose Fourier transforms are supported on $\mathbb{R}^n$. The construction allows bases defined on balls in $\mathbb{R}^n$ to be transferred to annuli in such a way that nice properties such as monogenicity are preserved. Multi-dimensional prolate functions and the prolate shift frames they generate will also be considered.

10.5. Geometric maximal functions associated with spheres

Speaker: Jongchon Kim (City University of Hong Kong)

Time: 19:00 Wed 8 December

Place(s):

Author(s): Jongchon Kim

This talk will be about maximal operators associated with a family of spheres, which include the classical spherical maximal function as a special case. We will study properties of sets, such as the Lebesgue measure and the Hausdorff dimension, containing a family of spheres which may be regarded as Nikodym sets for spheres. This talk will be based on a joint work with Alan Chang and Georgios Dosidis.

10.6. continuous metric and scalar curvature

Speaker: Man-Chun Lee (The Chinese University of Hong Kong)

Time: 15:00 Thu 9 December

Place(s):

Author(s): Man-Chun Lee

A classical Theorem in conformal geometry states that on a closed manifold with non-positive Yamabe invariant, a smooth metric achieving the invariant must be Einstein. In this talk, we will discuss some extension of the result in the singular setting. This is a joint work with L.-F. Tam.

10.7. Maximal and regularity estimates for averages over curves

Speaker: Sanghyuk Lee (Seoul National University)

Time: 18:00 Wed 8 December

Place(s):

Author(s): Sanghyuk Lee

This talk concerns the maximal and Sobolev regularity estimates for the averaging operator given by convolution with a measure on curves. In two dimensions, the problems are well understood. However, in higher dimensions, those problems turned out to be much more difficult and have been made left open until recently. In this talk, we present recent progress in the problems. This talk is based on joint work with Hyerim Ko and Sewook Oh.

10.8. Singular value estimates of commutators of Calderon–Zygmund operators— recent progresses on stratified Lie groups

Speaker: Ji Li (Macquarie University)
Time: 17:30 Tue 7 December
Place(s):
Author(s): Ji Li

Originated from Nehari and Coifman—Rochberg—Weiss, commutator of singular integral with a symbol function provides a connection between real, complex analysis and operator theory. The boundedness, compactness and Schatten class characterisations of commutator correspond to the symbol function to be in the BMO, VMO and Besov spaces, respectively. Moreover, it outlines the parallel story of the real Hardy space and weak factorization of these functions, and has important applications and links to PDEs and non-commutative analysis. In this talk I will briefly recall the history along this line, and then report on some of our recent progresses on Schatten class of commutator of singular integrals on certain stratified Lie groups.

10.9. Improved bounds for the Kakeya maximal conjecture using semialgebraic geometry

Speaker: Keith Rogers (Spanish National Research Council)
Time: 19:30 Wed 8 December
Place(s):
Author(s): Keith Rogers

The Kakeya problem considers tubes which point in different directions and the degree to which they can be compressed by positioning them strategically. On the one hand, we will see that the measure of any semialgebraic set that contains the tubes must satisfy the expected lower bound. The proof employs tools from real algebraic geometry including Gromov's algebraic lemma and Tarski's projection theorem. On the other hand, the expected bound holds in the absence of algebraic structure, by polynomial partitioning. Balancing between the two cases yields improved bounds for the Kakeya maximal conjecture in higher dimensions. This is joint work with Hickman, Katz and Zhang.

10.10. Vertical and horizontal Square Functions on a Class of Non-Doubling Manifolds

Speaker: Adam Sikora (Macquarie University)
Time: 17:00 Tue 7 December
Place(s):
Author(s): Adam Sikora and Julian Bailey

We consider a class of non-doubling manifolds $\mathcal{M}$ that are the connected sum of a finite number of N-dimensional manifolds of the form $\mathbb{R}^{n_i} \times \mathcal{M}_i$. We show that the vertical square function operator

$$Sf(x) := \left(\int_0^\infty \left| t\nabla (I + t^2\Delta)^{-M} f(x) \right| 2 \frac{dt}{t} \right)^{\frac{1}{2}}$$

is bounded on $L^p(\mathcal{M})$ for $1 < p < n_{min} = \min_i n_i$ and weak-type $(1,1)$. In addition, it will be proved that the reverse inequality $\|f\|_p \lesssim \|Sf\|_p$ holds for $p \in (n'_{min}, n_{min})$ and that S is unbounded for $p \geq n_{min}$ provided $2M < n_{min}$.
Similarly, for $M > 1$, we demonstrate that the horizontal square function operator

$$sf(x) := \left(\int_0^\infty \left| t^2\Delta (I + t^2\Delta)^{-M} f(x) \right|^2 \frac{dt}{t} \right)^{\frac{1}{2}}$$

is bounded on $L^p(\mathcal{M})$ for all $1 < p < \infty$ and weak-type $(1,1)$. Hence, for $p \geq n_{min}$, the vertical and horizontal square function operators are not equivalent and their corresponding Hardy spaces H^p do not coincide.
This is a joint work with Julian Bailey

10.11. Long-range phase coexistence models and the nonlocal Allen-Cahn equation

Speaker: Enrico Valdinoci (The University of Western Australia)
Time: 16:00 Fri 10 December
Place(s):
Author(s): Enrico Valdinoci

We will discuss classical and recent results concerning the Allen-Cahn equation and its long-range counterpart, focusing especially on rigidity and symmetry properties of global solutions.

10.12. Weighted geometric inequalities for hypersurfaces in space forms

Speaker: Yong Wei (University of Science and Technology of China)
Time: 14:00 Thu 9 December
Place(s):
Author(s): Yong Wei

We prove a family of new sharp geometric inequalities involving quermassintegrals and weighted curvature integrals for smooth closed hypersurfaces in space forms. The tools we shall use are the inverse curvature flow by Gerhardt and Urbas, and the locally constrained curvature flows introduced recently by Brendle, Guan and Li. As the key step, we give new monotone quantities along these flows. This is a joint work with Dr. Tailong Zhou in USTC.

10.13. On the entropy flow

Speaker: Glen Edward Wheeler (University of Wollongong)
Time: 16:00 Tue 7 December
Place(s):
Author(s): Glen Wheeler

In this talk I describe our new results on the entropy flow: the steepest descent $L^2(d\theta)$-gradient flow of the entropy functional (integral of $\log(kd\theta)$). The flow expands convex curves, with the radius of an initial circle growing like the square root of time. Our main result is that, for any initial curve (either immersed locally convex of class C^2 or embedded of class H^2 bounding a convex domain), the flow converges smoothly to a round expanding multiply-covered circle. This is joint work with Lachlann O'Donnell and Valentina-Mira Wheeler.

10.14. The Continuity Method on Kahler Manifolds

Speaker: Hosea Wondo (The University of Sydney)
Time: 16:30 Tue 7 December
Place(s):
Author(s): Hosea Wondo

The Continuity Method is a geometric evolution equation which is considered to be the discrete analogue of the Kähler-Ricci flow. Given a Kähler metric, it will attempt to deform the metric to a canonical metric of type Kähler-Einstein. As such, it was proposed by La Nave and Tian as an alternative method for carrying out the Analytic Minimal Model Program.

In the setting of Kähler manifolds with semi-ample canonical line bundles, we investigate curvature estimates for the continuity method. Roughly speaking, our result states that if we can find a well behaved deformation from a initial metric, then we can obtain curvature bounds for any other starting metric. In particular, we apply this to the product manifold case where such well behaved metrics can be constructed.

10.15. Stability of Volume Preserving Mean Curvature Flow in Hyperbolic Space

Speaker: Zhou Zhang (The University of Sydney)
Time: 14:30 Thu 9 December
Place(s):
Author(s): Zheng Huang, Longzhi Lin, Zhou Zhang

We consider the dynamic property of the volume preserving mean curvature flow. This flow was introduced by Huisken who also proved it converges to a round sphere of the same enclosed volume if the initial hypersurface is strictly convex in Euclidean space. We study the stability of this flow in hyperbolic space. In particular, we prove that if the initial hypersurface is hyperbolically mean convex and close to an umbilical sphere in the L^2-sense, then the flow exists for all time and converges exponentially to an umbilical sphere.

11. Harmonic Analysis and Hyperbolic PDEs

11.1. New Properties of Clifford Prolate Spheroidal Wave Functions (CPSWFs)

Speaker: Hamed Baghal Ghaffari (The University of Newcastle)
Time: 14:30 Fri 10 December
Place(s):
Author(s): Hamed Baghal Ghaffari

In this talk, we introduce important properties of Clifford Prolate Spheroidal Wave Functions (CPSWFs). We show that the radial part of CPSWFs satisfies the Sturm–Liouville theory and also some new features from CPSWFs which work for every dimension. We also present the spectral concentration problem and spectrum accumulation properties of the CPSWFs.

11.2. Local well-posedness for the Zakharov system in dimension d=2, 3

Speaker: Zijun Chen (Monash University)
Time: 15:00 Wed 8 December
Place(s):
Author(s): Zijun Chen

The Zakharov system in dimension $d = 2, 3$ is shown to have a local unique solution for any initial values in the space $H^s \times H^l \times H^{l-1}$, where a new range of regularity (s, l) is given, especially at the line $s - l = -1$. The result is obtained mainly by the normal form reduction and the Strichartz estimates.

11.3. Long-time dynamics of the Fisher-KPP nonlocal diffusion equation with free boundary

Speaker: Yihong Du (University of New England)
Time: 14:00 Wed 8 December
Place(s):
Author(s): Yihong Du

Propagation has been modelled by reaction-diffusion equations since the pioneering works of Fisher and Kolmogorov-Peterovski-Piskunov (KPP). Much new developments have been achieved in the past a few decades on the modelling of propagation, with traveling wave and related solutions playing a central role. In this talk, I will report some recent results obtained with several collaborators on the Fisher-KPP equation with free boundary and "nonlocal diffusion". A key feature of this nonlocal equation is that the propagation may or may not be determined by traveling wave solutions. There is a threshold condition on the kernel function which determines whether the propagation has a finite speed or infinite speed (known as accelerated spreading). For some typical kernel functions, we obtain sharp estimates of the spreading speed (whether finite or infinite).

11.4. Exact Egorov theorem

Speaker: Antoine Gansemer (Australian National University)
Time: 16:00 Wed 8 December
Place(s):
Author(s): Antoine Gansemer

TBA

11.5. The harmonic-measure distribution functions of multiply connected regions

Speaker: Arunmaran Mahenthiram (University of South Australia)

Time: 10:00 Fri 10 December

Place(s):

Author(s): Arunmaran Mahenthiram

A Brownian particle released from a point z_0 in a two-dimensional region D will move around randomly until it eventually hits the boundary of D. We are interested in the probability that it hits the boundary somewhere within distance r of the starting point z_0, for each value of r. Putting together these probabilities for all values of r gives a function $h(r)$ called the *harmonic-measure distribution function* or *h-function* of D with respect to z_0. This h-function encodes information about the shape of the boundary of D. In the past, h-functions have been calculated for many simply connected regions, such as discs, wedges, and halfplanes.

In this project we compute the h-functions not only for additional simply connected regions, but also for numerous multiply connected regions, such as a whole plane from which various line segments, discs or polygons have been deleted. The key tool we use for computing these previously inaccessible h-functions is a special function from the field of complex analysis, called the Schottky-Klein prime function. Many of these computations are too complicated to do by hand, and we use an implementation of the Schottky-Klein prime function in MATLAB. In addition, we have verified our results by using MATLAB to simulate the random motion of Brownian particles in simply and multiply connected regions.

11.6. Well-posedness of the Muskat and Peskin problems

Speaker: Quoc Hung NGUYEN (Chinese Academy of Sciences)

Time: 16:30 Wed 8 December

Place(s):

Author(s): Quoc Hung Nguyen

In this talk, I will present some ideas to prove well-posedness of the Muskat and Peskin problems in Critical spaces. Moreover, I also discuss how to use these ideas to improve Koch-Tataru theorem for the Navier-Stokes equations.

11.7. Pseudodifferential calculi using Weyl pairs on L^p

Speaker: Himani Sharma (The Australian National University)

Time: 14:00 Fri 10 December

Place(s):

Author(s): Himani Sharma

A pseudodifferential calculus on $\mathbb{R}^d$ can be seen as a joint functional calculus of standard position and momentum operators, $Q = (Q_1, ..., Q_d)$ and $P = (P_1, ..., P_d)$, given as multiplication by x_j and partial derivatives ∂_{x_j}, respectively. This calculus is defined for $a \in \mathcal{S}(\mathbb{R}^d)$ by

$$a(Q,P)f := \frac{1}{(2\pi)^d}\int_{\mathbb{R}^{2d}} \hat{a}(u,v)e^{iuQ+ivP}f dudv;\ f \in L^2(\mathbb{R}^d)$$

It can be generalised to a calculus of Weyl pairs acting on a Banach space X. A pair (A, B) of d-tuples $A = (A_1, ..., A_d)$ and $B = (B_1, ..., B_d)$ is called a Weyl pair if $iA_1, ..., iA_d$ and $iB_1, ..., iB_d$ generate bounded C_0-groups on X satisfying the following canonical commutation relation:

$$e^{isA_j}e^{itA_k} = e^{itA_k}e^{isA_j};\ \ e^{isB_j}e^{itB_k} = e^{itB_k}e^{isB_j}$$
$$e^{isA_j}e^{itB_k} = e^{-ist\delta_{jk}}e^{itB_k}e^{isA_j}$$

In this talk, we will show spectral multiplier estimates on this calculus for Weyl pairs and the abstract Harmonic oscillator obtained using the sum of the squares of these pairs. This generalises standard pseudo-differential operator estimates to abstract functional calculi with similar algebraic properties. We will also see the application of our results on Fock-Bargmann space.

11.8. Mattila-Sjolin distance problem for product sets

Speaker: Chun-Yen Shen (National Taiwan University)
Time: 13:30 Fri 10 December
Place(s):
Author(s): Chun-Yen Shen

The well-known Falconer's distance conjecture states that if E is a subset in $\mathbb{R}^d$ with $\dim_H(E) > \frac{d}{2}$, then its distance set $\Delta(E)$ has positive Lebesgue measure. It was Mattila and Sjölin who first proved a stronger result in 1999 that the distance set not only has positive Lebesgue measure but it contains a nonempty interval if $\dim_H(E) > \frac{d+1}{2}$, where $\dim_H(E)$ denotes the Hausdorff dimension of the set E, and $\Delta(E) := \{|x-y|; x, y \in E\}$. Since then only little is known toward the problem of proving a nonempty interval in the distance set even for product sets. In this talk, we will talk about our new results that improve the exponents of Mattila-Sjölin for general product sets. One of the key ingredients in our proofs is the reduction to parabolic distance set.

11.9. Single Observer Tomography via Nonlinear Waves

Speaker: Leo Tzou (The University of Sydney)
Time: 08:30 Wed 8 December
Place(s):
Author(s): Leo Tzou

Abstract: We show that, using the nonlinear interaction idea developed by Kurylev-Lassas-Uhlmann, a 3D Riemannian manifold can be uniquely determined by observing nonlinear waves at a single point. Building on this idea, we show that the conformal structure of a 1+3 hyperbolic Lorentzian manifold can be determined by measurements from a single observer.

11.10. Schatten properties of quantum derivatives on quantum tori

Speaker: xiao xiong (Harbin Institute of Technology)
Time: 13:00 Fri 10 December
Place(s):
Author(s): xiao xiong

The core ingredients of the quantized calculus, introduced by A. Connes, are a separable Hilbert space H, a unitary self-adjoint operator F on H and a C^*-algebra $\mathcal{A}$ represented on H such that for all $a \in \mathcal{A}$ the commutator $[F, a]$ is a compact operator on H. Then the quantized differential of $a \in \mathcal{A}$ is defined to be the operator $\mathbf{d}a = i[F, a]$. In the classical setting, the Hilbert or Riesz transforms play the role of the self-adjoint operator F, so the quantum derivatives are in fact the commutators of singular operators. The Schatten properties of these commutators of singular operators are characterized by Sobolev or Besov spaces. On quantum tori $\mathbb{T}^d_\theta$, the spectral triple $(\mathcal{A}, F, H)$ is built in a similar way as on the classical d-torus. In this talk, I will talk about the characterizations of the Schatten properties of quantum derivatives on quantum tori by the quantum analogues of Sobolev or Besov spaces.

12. Indiginising University Mathematics

12.1. Jindaola

Speaker: Maureen Edwards (University of Wollongong)
Time: 14:00 Thu 9 December
Place(s):
Author(s): Maureen Edwards, Aidan Sims, Jade Kennedy

The Jindaola program engages participants in authentic knowledge-based relationships between Aboriginal knowledges and discipline knowledges with an emphasis on connections with local Aboriginal communities and their Knowledge.

In 2019, a team of UOW academics from the Faculty of Engineering and Information Sciences started a journey of unlearning and embedding to create an opportunity for meaningful engagement with Indigenous knowledges across our diverse STEM disciplines.

This session will give an introduction to Jindaola and some mathematics discipline outcomes from the program to date.

13. Integrable systems and Mathematical Physics

13.1. Symmetry protected topological (SPT) phases of infinite fermion chains

Speaker: Chris Bourne (Tohoku University)
Time: 14:00 Thu 9 December
Place(s):
Author(s): Chris Bourne

Symmetry protected topological (SPT) phases have recently attracted a lot of attention from physicists and mathematicians as topological classification scheme for gapped ground states. In this talk, I will briefly review the operator algebraic approach to SPT phases in the thermodynamic limit and how we can define group cohomology-valued indices for one-dimensional fermionic ground states. This is joint work with Yoshiko Ogata (Univ. Tokyo).

13.2. The topological vertex and the infinite wedge

Speaker: Norman Do (Monash University)
Time: 14:30 Thu 9 December
Place(s):
Author(s): Norman Do

The theory of the topological vertex was inspired by string theory and allows one to explicitly compute Gromov–Witten invariants of toric Calabi–Yau threefolds. In this talk, I will explain how the infinite wedge formalism can be used to prove constraints for the topological vertex that are deeply motivated by tropical geometry. These constraints then allow one to deduce integrability properties for the topological vertex. This is joint work with Brett Parker.

13.3. Minkowski Billiards on the Hyperboloid of One Sheet

Speaker: Sean Gasiorek (The University of Sydney)
Time: 13:30 Thu 9 December
Place(s):
Author(s): Sean Gasiorek

We give a review of Euclidean and pseudo-Euclidean billiards in the plane and in d-dimensional space. If the billiard table is bounded by confocal quadrics, periodic trajectories can be expressed in algebro-geometric terms based on work of Poncelet, Cayley, and others. Our work focuses on a billiard problem for compact domains on a hyperboloid of one sheet bounded by confocal quadrics using the pseudo-Euclidean metric. Using a matrix factorization technique of Moser and Veselov, the billiard is shown to be integrable in the sense of Liouville. Further, we derive a Cayley condition for the billiards under consideration and explore geometric consequences. This is joint work with Milena Radnović (University of Sydney).

13.4. Asymptotic Analysis and Special Solutions of a Family of Painlevé-Like Equations

Speaker: Joshua Holroyd (The University of Sydney)
Time: 14:30 Wed 8 December
Place(s):
Author(s): Joshua Holroyd

We consider a family of nonlinear ODEs that includes the second Painlevé equation and deduce the asymptotic behaviour of solutions. We show how such equations may arise in mathematical models of physical phenomena. We find unique solutions which are singularity-free in wide sectors of the complex plane, analogous to 'tritronquée' solutions studied by Boutroux. We study the existence and uniqueness of the generalised Hastings-Mcleod solution of Painlevé II.

13.5. Motion and monodromy

Speaker: Nalini Joshi (The University of Sydney)
Time: 14:00 Wed 8 December
Place(s):
Author(s): Nalini Joshi

Newton was inspired by Kepler's laws of planetary motion to study motion on curves. This led him immediately to transcendental functions, that is, functions that cannot arise as solutions of polynomial equations. I will give an overview of these results before considering monodromy: the study of how a function changes as its independent variable moves around a singularity. These two themes come together in the study of solutions of the Painlevé and discrete Painlevé equations and I will describe some new results about such solutions.

13.6. 16 new Yang-Baxter maps

Speaker: Andrew Kels (International School for Advanced Studies (SISSA))
Time: 17:30 Tue 7 December
Place(s):
Author(s): Andrew Kels

The Yang-Baxter equation is one of the important equations in the area of integrable systems and mathematical physics. In 1990, Drinfeld [1] introduced the concept of set-theoretical solutions to the Yang-Baxter equation (YBE). For a set X, these solutions are maps $R : X \times X \to X \times X$ which satisfy the set-theoretical form of the YBE

$$R_{23} \circ R_{13} \circ R_{12} = R_{12} \circ R_{13} \circ R_{23}, \tag{1}$$

regarded as an equality of maps on $X \times X \times X$ to itself, where R_{ij} acts as R on the i-th and j-th factors and as the identity on the other. In 2002, Veselov [2] has studied such solutions from a dynamical point of view, and gave them the now commonly used name Yang-Baxter maps.

In 2015, Bazhanov and Sergeev [3] connected Yang-Baxter maps to quantum groups and quantum and classical R-matrix structures. This was the main motivation for my work [4], where I used solutions of the classical star-triangle relations related to hypergeometric integrals to derive a new family of 16 Yang-Baxter maps for $X = \mathbb{CP}^1 \times \mathbb{CP}^1$. I will provide an overview of these new Yang-Baxter maps and discuss their derivation, their properties, and connections to integrable partial difference equations in the Adler, Bobenko, and Suris (ABS) classification [5].

References

[1] V. G. Drinfeld, *On some unsolved problems in quantum group theory*, Quantum groups (Leningrad, 1990), Lecture Notes in Mathematics, edited by P. P. Kulish (Springer Verlag, Berlin, 1992), Vol. 1510, pp. 1–8.

[2] A. P. Veselov, Yang-Baxter maps and integrable dynamics, *Phys. Lett.* **A314**, 214—221 (2003).

[3] V. V. Bazhanov and S. M. Sergeev, Yang-Baxter maps, discrete integrable equations and quantum groups, *Nucl. Phys.* **B926** (2018) 509–543.

[4] A. P. Kels, Two-component Yang-Baxter maps associated to integrable quad equations, hypergeometric integrals, and the star-triangle relations, arXiv:1910.03562.

[5] V. E. Adler, A. I. Bobenko, and Y. B. Suris, Classification of integrable equations on quad-graphs. The consistency approach, *Commun. Math. Phys.* **233** (2003) 513–543.

13.7. Asymptotic behaviours of q-orthogonal polynomials from a q-Riemann Hilbert Problem

Speaker: Tomas Lasic Latimer (The University of Sydney)
Time: 15:00 Wed 8 December
Place(s):
Author(s): Tomas Lasic Latimer

q-orthogonal polynomials appear in many areas of applied mathematics and physics, particularly quantum physics but are currently not well understood. We extend a method first developed by Deift *et al.* for semi-classical orthogonal polynomials to deduce the asymptotic behaviours of q-orthogonal polynomials from a model Riemann Hilbert Problem (RHP). In this talk we focus on the model q-RHP and show that our new results demonstrate certain universal properties shared by q-orthogonal polynomials. Furthermore, we highlight the connection between our results and earlier work in q-difference equations and q-RHP theory. (References include: Carmichael, R.D. (1912), doi:10.2307/2369887 and, Joshi, N. and Lasic Latimer T. (2021), doi:10.1098/rspa.2021.0452.)

13.8. From Painlevé functions to Heun accessory parameters and back

Speaker: Oleg Lisovyy (Université de Tours)
Time: 18:00 Wed 8 December
Place(s):
Author(s): Oleg Lisovyy

The reconstruction of linear ODEs from their monodromy leads to two interesting classes of special functions: Heun accessory parameters (for the simplest 2nd order scalar ODEs) and Painlevé functions (for the simplest 1st order 2×2 linear systems). I will discuss several approaches to computation of these functions, such as Hill and Widom determinant, continued fractions and series over partitions. After recalling a classical relation between Heun and Painlevé equations, I will explain how it leads to identities expressing Heun accessory parameters in terms of Painlevé functions and vice versa.

13.9. Singularities of Whitham Deformations

Speaker: Vishnu Mangalath (None)

Time: 09:00 Thu 9 December

Place(s):

Author(s): Vishnu Mangalath

Constant mean curvature planes of finite type in Euclidean 3-space are in correspondence with spectral data, consisting of a hyperelliptic (spectral) curve, a real 2-plane spanned by two meromorphic differentials, and a line bundle. A class of deformations one can consider are known as Whitham or period preserving deformations. Singularities of Whitham deformations can occur if the differentials have common roots on the spectral curve. In this talk we will summarise the spectral data correspondence for CMC tori and planes in $\mathbb{R}^3$, and study singularities that arise when considering Whitham deformations in the moduli space of CMC planes. In particular we will discuss a possible method for deforming within the space of singular points of the Whitham equations, and show that solutions are related to certain graphs on $\mathbb{C}P^1$

13.10. Painlevé VI, rational potentials and cubic algebras

Speaker: Ian Marquette (University of Queensland)

Time: 08:00 Thu 9 December

Place(s):

Author(s): Ian Marquette

I will discuss the six Painlevé transcendents which were obtained by Painleve, Gambier and Fuchs in early 1900. They play an important role in classification of ordinary differential equations and they were related to several areas in physics and mathematics such as reduction of various nonlinear differential equations of mathematical physics, relativity, statistical mechanics, and quantum field theory. Their connection with non-relativistic quantum mechanics is much more recent. I will discuss a model involving the sixth Painlevé transcendent and the connection with Jacobi exceptional orthogonal polynomial and recent works. This models has a cubic algebra and this is used to obtain the energy spectrum. Those algebraic structures can also be observed in other context of mathematical physics.

This is joint work with Sarah Post and Lisa Ritter from University of Hawaii:

Ian Marquette, Sarah Post, Lisa Ritter, Journal of Physics A: Mathematical and Theoretical 53 (50), 50LT01 (2020), arXiv:2006.12639

I. Marquette, S. Post, L. Ritter, A family of fourth-order superintegable systems with rational potentials related to Painlevé VI, arXiv:2108.13533

13.11. Towards a factorised solution of the Yang-Baxter equation with $U_q(\mathfrak{sl}_n)$ symmetry

Speaker: Benjamin Morris (Australian National University)

Time: 17:00 Tue 7 December

Place(s):

Author(s): Benjamin Morris

I will discuss the parameter permutation method for constructing factorised solutions of the Yang-Baxter equation related to the algebras $\mathcal{A} = U(\mathfrak{sl}_n)$, or $U_q(\mathfrak{sl}_n)$. Solutions are R-matrices which act in the product of differential or q-difference representations of $\mathcal{A}$ on a complex function space in $n(n-1)/2$ variables. A particular focus is the $U_q(\mathfrak{sl}_4)$ case where we obtain a factorised L-operator that generalises known expressions in the $\mathfrak{sl}_4$ case, and the smaller rank $U_q(\mathfrak{sl}_n)$ cases. We also obtain most elementary permutation operators for the $U_q(\mathfrak{sl}_4)$ L-operator which are used to write a factorised solution of the YBE.

13.12. Integrability of normal distributions: A Stefan-Sussmann theorem and neat foliations by manifolds with boundary

Speaker: David Perrella (The University of Western Australia)

Time: 16:30 Tue 7 December

Place(s):

Author(s): David Perrella, David Pfefferlé, and Luchezar Stoyanov

This work focuses on what we call normal distributions (or normal plane fields). These distributions are on manifolds with boundary and contain vectors transverse to the boundary along its entirety. Plain integral manifolds are not enough to "integrate" a normal distribution. Instead, we need to add boundary. Under our choice of definitions, the theory is found to be entirely analogous with that of integrable distributions due to Frobenius, Stefan, and Sussmann. For example, a 1-1 correspondence is established between what we call neatly integrable normal distributions and neat foliations by manifolds with boundary.

13.13. Relative helicity formulae in magnetostatics from cohomological methods

Speaker: David Pfefferlé (The University of Western Australia)

Time: 16:00 Tue 7 December

Place(s):

Author(s): David Pfefferlé

Magnetostatics defines a class of boundary value problems in which the topology of the domain plays a subtle role. For example, representability of a divergence-free field as the curl of a vector potential comes about because of homological considerations. Understanding gauge freedom is particularly important for the computation and interpretation of total magnetic helicity, which is the volume integral of the gauge-dependent quantity $A \cdot B$. On a simply-connected orientable three-dimensional Riemannian manifold, the total helicity is the asymptotic Hopf invariant of the magnetic field, measuring the average linking of its field-lines. This interpretation extends to manifolds with boundary only under certain conditions and under certain gauge choices. Here, we apply Hodge decomposition and de Rham cohomology to represent magnetic fields in toroidal volumes via potential 1-forms. An advantage of the homological approach is the recovery of classical results without explicit coordinates and assumptions about the fields on the exterior of the domain. In particular, a detailed construction of minimal gauges and a formal proof of relative helicity formulae are presented.

13.14. Resonances of elliptical billiards

Speaker: Milena Radnovic (The University of Sydney)

Time: 16:00 Wed 8 December

Place(s):

Author(s): Milena Radnovic

We study resonant billiard trajectories within quadrics in the d-dimensional Euclidean space and relate them to the theory of approximation, in particular the extremal rational functions on the systems of d intervals on the real line. This fruitful link enables us to prove fundamental properties of the billiard dynamics and to provide a comprehensive study of a large class of non-periodic trajectories of integrable billiards. A key ingredient is a functional-polynomial relation of a generalized Pell type. Applying further these ideas and techniques to s-weak billiard trajectories, we come to a functional-polynomial relation of the same generalized Pell type.

13.15. The Supersymmetric Box-Ball System

Speaker: Mitchell Ryan (The University of Queensland)

Time: 16:30 Wed 8 December

Place(s):

Author(s): Mitchell Ryan, Benjamin Solomon

The box-ball system (BBS) is a cellular automaton, and is an ultradiscrete analogue of the Korteweg–De Vries (KdV) equation (a non-linear PDE used to model water waves). The classical BBS consists of a one-dimensional lattice (boxes) together with particles (balls) that can be placed at lattice points. The time evolution of the system is given by a row-to-row transfer matrix, which can be derived from the affine general linear Lie algebra $\widehat{\mathfrak{gl}}_2$. Hikami–Inoue generalised the BBS using the Lie superalgebra

$\widehat{\mathfrak{gl}}(m|n)$. We further generalise this BBS using crystal bases of $\widehat{\mathfrak{gl}}(m|n)$ and find behaviour similar to solitonic waves, as in the classical BBS.

13.16. Lump interactions with plane solitons

Speaker: Yury Stepanyants (University of Southern Queensland)

Time: 15:00 Thu 9 December

Place(s):

Author(s): Yury Stepanyants, Dmitry Zakharov, Vladimir Zakharov

We present the detailed analysis of interactions of two-dimensional solitary waves called lumps and one-dimensional line solitons within the framework of the Kadomtsev–Petviashvili equation describing wave processes in media with positive dispersion. We show that line solitons can emit or absorb lumps or periodic chains of lumps; they can interact with each other by means of lumps. Within a certain time interval, lumps or lump chains can emerge between two line solitons and disappear then due to absorption by one of the solitons. This phenomenon resembles the appearance of rogue waves in the oceans. The results obtained can be applicable to the description of physical processes occurring in plasma, fluids, solids, nonlinear optical media, and other fields.

14. Mathematics Education

14.1. Student and staff approaches to academic integrity in calculation-based assessments

Speaker: Julia Collins (Edith Cowan University)

Time: 16:30 Tue 7 December

Place(s):

Author(s): Julia Collins

Face-to-face examinations have long been a cornerstone of university mathematics assessment, but with the advent of Covid-19 universities are increasingly opting for online assessments. The difficulty in monitoring students taking large-scale mathematics assessments in an online setting creates a significant challenge in maintaining assessment integrity. Students have the potential to seek assistance from friends, family, tutors, online 'tutoring' sites such as Chegg, and online calculators such as Wolfram Alpha that not only present the solution to a problem, but the working as well.

Our research project seeks to investigate student and academic staff perceptions in relation to behaviours that exist in a 'grey area' separating clear misconduct from appropriate/reasonable use of available resources and technology. In a recent survey of Australian university staff and students, we asked participants to rate various academic misconduct scenarios on a scale of "No misconduct" to "Clear misconduct". These scenarios range from more traditional sources of help, such as friends and tutors, to newer forms of help such as online calculators and online forums.

This talk will discuss the methodology of the survey instrument and present preliminary findings from the survey data, seeking to explore the consistency with which students categorise specific scenarios as clear misconduct, and the differences between staff and student attitudes towards academic misconduct.

14.2. Online engagement in advanced 2nd year mathematics

Speaker: Zsuzsanna Dancso (The University of Sydney)

Time: 13:30 Fri 10 December

Place(s):

Author(s): Zsuzsanna Dancso, George Papadopoulos, Stephen Morgan

COVID has turned tertiary education on its head. Throughout the crisis we were most concerned about our first-year students, the students who needed extra support, the students in large service courses: it is natural to focus on the most vulnerable cohorts first. In the first semester of 2021 my co-authors and I ran a small study to find out how the other end of the spectrum was faring: an 80-student cohort in a second-year advanced mathematics unit at the University of Sydney. These are predominantly high-achieving students who are motivated to study mathematics at a deep level. Did these students remain engaged despite the challenges of online learning? How can we help them overcome the the Zoom-induced isolation of 2020-2021? And can the lessons from this study inform our return to face-to-face teaching in 2022 (we hope)?

14.3. Evidence bases in Mathematics Education

Speaker: Antony Edwards (Swinburne University of Technology)
Time: 17:00 Tue 7 December
Place(s):
Author(s): Antony Edwards

In this talk I will consider what constitutes a persuasive evidence base for studies that explore the effectiveness of mathematics teaching and learning approaches in higher education, and the challenges involved in producing such evidence. Recently, there has been a strong shift to encourage innovative practices whether they be a flipped or blended learning pedagogy, the removal of invigilated exams, or the continuation of education measures necessitated due to the COVID-19 pandemic. But what evidence backs up these shifts, and more broadly, what evidence base justifies any wider rollout of a novel learning and teaching approach?

I will present occasions where learning and teaching outcome evidence that was initially persuasive quickly descends into baseless smoke and mirrors; yet still may resonate with educators and students. I consider the role of learning analytics and student feedback surveys, comparisons of evidence by standardised effect sizes, randomised and pseudo-randomised trials and qualitative approaches as we strive to critically appraise evidence bases for mathematics education.

14.4. Flat Curriculum with Self-Contained Micro Topics

Speaker: Attila Egri-Nagy (Akita International University)
Time: 14:00 Fri 10 December
Place(s):
Author(s): Attila Egri-Nagy

The traditional way of presenting mathematical knowledge is logical deduction, which implies a monolithic structure with topics in a strict hierarchical relationship. Despite many recent developments and methodical inventions in mathematics education, many curricula are still close in spirit to this hierarchical structure. However, this organisation of mathematical ideas may not be the most conducive way for learning mathematics. In this paper, we suggest that flattening curricula by developing self-contained micro topics and by providing multiple entry points to knowledge by making the dependency graph of notions and subfields as sparse as possible could improve the effectiveness of teaching mathematics.
This talk will elaborate on this potentially controversial idea and it summarizes our recently published paper on this topic. `https://doi.org/10.3390/philosophies6030076`

14.5. Perspectives on partnership: exploring feedback opportunities for mathematics tutors through student-staff partnership

Speaker: Ava Greenwood (The University of Queensland)
Time: 16:30 Fri 10 December
Place(s):
Author(s): Ava Greenwood, Jemma Benzie, Sabrina Morrison

Tutorials form an important part of the learning sequence. Tutorials offer the flexibility to deliver personalised, student-centered learning experiences and promote opportunities for collaboration and differentiation across both face-to-face and online environments. To facilitate successful learning outcomes for students, tutors need to develop an increasingly comprehensive pedagogical toolkit. Despite these demands, there are often limited opportunities for tutors to access training and professional development or receive feedback on their teaching practice. To best understand the challenges facing mathematics tutors and to give tutors a voice in shaping opportunities for their own development as educators, we embarked on a partnership journey to identify and trial feedback mechanisms that are valuable, equitable, and accessible to tutors. In this presentation we will present an overview of the co-developed approaches to feedback resulting from this project and reflect on both student and staff perspectives of working in partnership.

14.6. Looking for answers

Speaker: Deborah Jackson (La Trobe University)
Time: 17:00 Fri 10 December
Place(s):
Author(s): Deborah Jackson

Everyone is looking for answers, particularly in mathematics, and particularly students. However, knowing an answer to a problem does not necessarily mean that the problem's solution has been understood, nor even sought. In mathematics, the expertise in solving a problem far outweighs simply knowing the answer to it. Yet "answers only" pervade many problem-solving methods, with answers from computers, calculators, tables, texts, rote learning, all giving quick and easy ways to enhance problem solving. Where is the cut-off point? Where does "answers only" interrupt logical/mathematical reasoning when seeking a solution? Are we helping students or hindering them when we encourage them to solve problems via the methods above? This paper discusses why mathematics support is crucial for filling the gaps in a student's journey to successful problem solving by enabling them to ask for individual guidance. Within support facilities, students can be encouraged to inquire further about the mathematical reasoning behind their problem solving. It's the seeking of "why" and "how" a problem is solved that leads to true motivation and successful outcomes, and it is often individual support that leads to "light bulb" moments for students seeking help.

14.7. Student Perspectives on Summer School versus term-time for Undergraduate Mathematics

Speaker: George Papadopoulos (The University of Sydney)
Time: 15:00 Fri 10 December
Place(s):
Author(s): George Papadopoulos

In recent studies, academics at The University of Sydney presented both quantitative and qualitative evidence supporting the claim that students undertaking undergraduate mathematics units of study achieve superior learning outcomes and personal satisfaction by completing units at summer school rather than during term-time. Follow-up studies present mixed-methods analyses of data coming from students that participated in an online survey, and a subset of which that attended face-to-face interviews. These students undertook undergraduate mathematics units of study at The Sydney Summer School at The University of Sydney within the period 2009 to 2016. An initial phenomenography-type categorisation was performed upon open-ended survey responses and interview transcripts, producing catalogues of both positive and negative factors that influence student learning experiences and outcomes between the two delivery modes. By developing a novel yet rigorous implementation of word clouds as analytical tools, we produced a series of "factor clouds" which capture the essences of the students' experiences. Finally, we discuss the degrees of 'positive' and 'negative' sentimentality of the students' statements during the interviews.

14.8. Engaging high-achievers through weekly authentic assessment tasks

Speaker: Adam Piggott (Australian National University)
Time: 16:00 Tue 7 December
Place(s):
Author(s): Adam Piggott

Requiring a quantitative reasoning course for first-year high-achieving students can be problematic—the students don't think they need it, but the faculty think they do. We report on the redevelopment of a first-semester first-year course in quantitative reasoning in science for high-achieving students at the University of Queensland. Prior to the redevelopment, high-achieving students were underwhelmed by the course. By implementing weekly authentic assessment tasks, students were pushed into deeper thinking and further developed scientific communication skills. The redevelopment applied the pedagogical principles of constructive alignment, authentic assessment and criteria-referenced assessment.

14.9. Applying the "Care Factor" in the Maths and Stats Classroom

Speaker: Leesa Sidhu (University of New South Wales Canberra)
Time: 16:00 Fri 10 December
Place(s):
Author(s): Leesa Sidhu

This talk examines the importance of the "Care Factor" in the Maths and Stats classroom. It shows how an evidence-based theory, self-determination theory, can be used as a framework to assist in developing and/or improving simple strategies that support students' three psychological needs, relatedness, competence and autonomy, leading to increased student success and thus wellbeing.

A case study which illustrates the importance of the "Care Factor" in the Maths and Stats classroom is examined. It focusses on wellbeing-supportive strategies used in a compulsory statistics course for Arts and Business students, which is particularly challenging to teach as many students lack confidence in maths and are well outside their comfort zones. Within a supportive and encouraging classroom environment, students in this course are able to overcome "maths anxiety" and experience success and a sense of achievement, in some cases for the first time in their maths study.

14.10. AustMS Accreditation of Mathematics Degrees and Programs

Speaker: Chris Tisdell (University of New South Wales)

Time: 17:30 Fri 10 December

Place(s):

Author(s): Chris Tisdell

This purpose of this session is to share the details of the new AustMS accreditation process for mathematics degrees and programs at Australian universities. It updates the previous version from 2002.

Many professional mathematicians have some shared idea of what a body of mathematical knowledge involves for university study specialisation in mathematics (eg, content and curriculum), and which competencies mathematics graduates should have (eg, certain graduate capabilities). Many mathematics programs across Australian universities reflect this with some shared degree of uniformity.

So, why bother with an accreditation scheme at all? There are at least three strong and interconnected positions to support such a program:

- Public certification;
- Quality assurance;
- Defence of standards.

Since the establishment of the Tertiary Education Quality and Standards Agency (TEQSA) by the Australian Government in 2011, the national university sector has been subjected to increased scrutiny regarding quality assurance and regulation in higher education. Indeed, national legislation such as the Higher Education Standards Framework (HESF) and the Australian Quality Framework (AQF) contain somewhat broad expectations, such as typical achievements of graduates who have been awarded a bachelor or honours degree.

Discipline-level quality assurance standards and processes are clearly beyond the expertise of overarching government agencies, and this responsibility has a strong tradition of being met by professional societies. For example, for many years, professional degrees involving engineering and technology have been accredited by organisations such as Engineers Australia and the Australian Computer Society. In science, there is a tradition of accreditation in physics and chemistry by the Australian Institute of Physics and the Royal Australian Chemical Institute, respectively. In statistics, The Statistical Society of Australia has been actively accrediting statistics degrees across Australian universities.

In establishing and developing its existing accreditation system, the AustMS aims to continue to:

- ensure high quality teaching and learning of mathematics at Australian universities;
- promote and assess the capabilities that mathematics graduates should have;
- provide institutions with an opportunity to demonstrate that these standards are being met.

14.11. Reigniting mathematical and statistical thinking for final year science students

Speaker: Frank Valckenborgh (Macquarie University)

Time: 14:30 Fri 10 December

Place(s):

Author(s): Ayse Bilgin & Frank Valckenborgh

In a third-year capstone unit for science students, the curriculum is designed around the UN Sustainable Development Goals (UN SDGs). The assessments are structured such that the main assessment is a group based-project proposal that addresses one or more of the UN SDGs with a final written report and corresponding video pitch/presentation. The majority of these students are enrolled in majors in which they may have completed a first-year mathematics and/or statistics unit, but no further studies in mathematics and/or statistics. The authors have used this opportunity to develop some student-centred activities that specifically address the mathematical and statistical critical thinking skills of these students before they graduate, and at the same time provide additional perspective on the importance of quantitative thinking in issues of sustainability. The mathematical thinking component is based on Al Bartlett's celebrated lecture Arithmetic, Population, and Energy (Bartlett, 1978), and evolves around several simple in-class activities that relate to linear and exponential growth, embedded into a minimum of theory to provide the conceptual framework. The statistical thinking is based on Wild & Pfannkuch (1999) and uses additional examples to emphasise how statistics should be reported. In this presentation, we will provide more detail about these activities which might be adopted/adapted by others for their classes.

Bartlett, A. (1978). Forgotten fundamentals of the energy crisis. American Journal of Physics, 46: 876–888.

Wild C.J. & Pfannkuch M. (1999). Statistical Thinking in Empirical Enquiry. International Statistical Review. 67(3): 223-265.

14.12. Contrarian calculus

Speaker: David Yost (Federation University Australia)

Time: 13:00 Fri 10 December

Place(s):

Author(s): David Yost

I would like to discuss three independent topics in the teaching of integration, but there will surely be enough time for at most two.

1. I will indicate how (and perhaps why) to teach integral calculus before differential calculus. This may be unpopular, because it goes against the group-think of the calculus textbook industry.

2. What did Fubini really do?

15. Number Theory and Algebraic Geometry

15.1. Uniform rational approximation to a number and its consecutive powers

Speaker: Dzmitry Badziahin (The University of Sydney)

Time: 14:00 Wed 8 December

Place(s):

Author(s): Dzmitry Badziahin

For a transcendental number $\xi \in \mathbb{R}$, its exponent $\hat{\lambda}_n(\xi)$ of Diophantine approximation is defined as the supremum of all $\lambda > 0$ such that the system of inequalities

$$\max_{1\le i\le n} ||q\xi^i|| \le Q^{-\lambda}, \quad 1 \le q \le Q$$

has a solution $q \in \mathbb{Z}$ for all large values of Q. It is one of the most mysterious exponents of Diophantine approximation. For example, for $n \ge 3$ we even do not know if it can take any value apart from $1/n$.

I will talk about recent developments in an understanding of $\hat{\lambda}_n(\xi)$, some of them are achieved by the speaker and some others by Roy, Poëls, Schleichitz and others. In particular, we will introduce non-trivial relations between $\hat{\lambda}_n(\xi)$ and other exponents of Diophantine approximations for ξ.

15.2. Continued fractions and Improvements to Dirichlet's theorem

Speaker: Ayreena Bakhtawar (UNSW Sydney)

Time: 15:00 Wed 8 December

Place(s):

Author(s): Ayreena Bakhtawar

Continued fraction expansion is a vital tool in studying the problems in Diophantine approximation. By using the continued fractions, Khintchine and Jarnik theorems are concerned with the growth of large partial quotients whereas, it has been shown by Kleinbock and Wadleigh in 2018 that improvements to Dirichlet's theorem is concerned with the growth of the product of consecutive partial quotients. In this talk I will discuss some measure theoretic results associated with the set of Dirichlet non-improvable numbers.

15.3. An explicit version of Chen's theorem

Speaker: Matteo Bordignon (University of New South Wales Canberra)
Time: 18:30 Wed 8 December
Place(s):
Author(s): Matteo Bordignon

We will prove the first completely explicit version of Chen's theorem, which states that all sufficiently large even integers can be written as the sum of a prime and another integer that is the product of at most two primes. Specifically, we will prove that Chen's theorem holds for all N ¿ exp(exp(36)) and from this that all even integers can be written as the sum of a prime and a integer that is the product of at most exp(33) primes. This is the main result of my PhD thesis.

15.4. Primes between powers

Speaker: Michaela Cully-Hugill (University of New South Wales Canberra)
Time: 18:00 Wed 8 December
Place(s):
Author(s): Michaela Cully-Hugill

Legendre conjectured that there is at least one prime between all consecutive squares. However, even assuming the Riemann hypothesis we have yet to see a proof of this statement. There are results that come close: on probabilistic grounds, or for almost-primes, but these are typically inexplicit. For an explicit result, the best we have is for primes between consecutive cubes, n^3 and $(n+1)^3$, for integers $n > \exp(\exp(33.3))$. We can also ask how large the power, say m, needs to be to find a prime between all consecutive m^{th} powers. Using more recent explicit estimates, I'll give an updated answer to this question.

15.5. Partitions into k-th Powers

Speaker: Kevin Fergusson (Bond University)
Time: 13:00 Fri 10 December
Place(s):
Author(s): Kevin J. Fergusson

An asymptotic estimate is obtained for the number of partitions of the positive integer n into unequal k-th powers, with each k-th power exceeding m. The estimate holds uniformly with respect to integers m such that m = o(exp(log n)/(1+k)), as n becomes arbitrarily large.

15.6. Explicit Estimates for Dirichlet L-functions

Speaker: Forrest James Francis (Australian Defence Force Academy)
Time: 19:00 Wed 8 December
Place(s):
Author(s): Forrest J. Francis

For a Dirichlet character χ modulo q and its associated L-function, $L(s,\chi)$, it is regularly of interest for one to know about the size of $L(s,\chi)$ inside the critical strip. In this talk, we'll see how to use simple techniques to furnish explicit bounds for $L(s,\chi)$ whenever an explicit version of the character sum estimate known as Burgess' bound is available for χ. We will use partial summation to determine bounds along vertical lines $\Re(s) = 1 - \frac{1}{r}$, where r is a parameter from Burgess' bound. These bounds will then be connected across the critical strip using a trick due to Rademacher.

15.7. Curious properties of generalized Lucas numbers

Speaker: Hayder Hashim (Kufa University, Faculty of Computer Science and Mathematics)
Time: 19:30 Wed 8 December
Place(s):
Author(s): Hayder R. Hashim

In 1953 Stancliff [**2**] noted an interesting property of the Fibonacci number $F_{11} = 89$. One has that

$$\frac{1}{89} = \frac{F_0}{10} + \frac{F_1}{10^2} + \frac{F_2}{10^3} + \frac{F_3}{10^4} + \frac{F_4}{10^5} + \frac{F_5}{10^6} + \dots.$$

De Weger [**1**] determined all $x \geq 2$ for which

$$\frac{1}{F_n} = \sum_{k=1}^{\infty} \frac{F_{k-1}}{x^k}.$$

In 2014 Tengely [**3**] extended the above result by studying the solutions (n, x) of the equation

$$\frac{1}{U_n(P_2, Q_2)} = \sum_{k=1}^{\infty} \frac{U_{k-1}(P_1, Q_1)}{x^k},$$

for certain pairs $(P_1, Q_1) = (P_2, Q_2)$, where $\{U_n(P, Q)\}$ denotes the Lucas sequence of the first kind at the nonzero parameters P and Q that is defined by

$$U_0 = 0, U_1 = 1, \quad U_n = PU_{n-1} - QU_{n-2} \quad \text{for} \quad n \geq 2.$$

In this talk we focus on extending all of the above results by investigating the solutions (n, x) with $x \geq 2$ and $n \geq 0$ of the equations

- $$\frac{1}{U_n(P_2, Q_2)} = \sum_{k=1}^{\infty} \frac{U_{k-1}(P_1, Q_1)}{x^k},$$
  for certain pairs $(P_1, Q_1) \neq (P_2, Q_2)$ with which the Lucas sequence of the first kind $\{U_n\}$ at such pairs is nondegenerate, with $Q_1, Q_2 \in \{-1, 1\}, 1 \leq P_1, P_2 \leq 3$.
- $$\frac{1}{V_n(P_2, Q_2)} = \sum_{k=1}^{\infty} \frac{V_{k-1}(P_1, Q_1)}{x^k},$$
  for certain pairs $(P_1, Q_1) = (P_2, Q_2)$ and $(P_1, Q_1) \neq (P_2, Q_2)$. Moreover, we here consider all of the degenerate and nondegenerate Lucas sequences of the second kind $\{V_n\}$ in case where we have $Q \in \{-1, 1\}$ and $-2 \leq P \leq 4$. Note that the Lucas sequence of the second kind is defined by the relation
  $$V_0 = 2, V_1 = P, \quad V_n = PV_{n-1} - QV_{n-2} \quad \text{for} \quad n \geq 2.$$

References

[1] B. M. M. de Weger, *A curious property of the eleventh Fibonacci number*, Rocky Mountain J. Math., 25 (1995), pp. 977–994.

[2] F. Stancliff, *A curious property of a_{ii}*, Scripta Math.,19:126, 1953.

[3] Sz. Tengely,On the Lucas sequence equation $\frac{1}{U_n} = \sum_{k=1}^{\infty} \frac{U_{k-1}}{x^k}$, *J. Period. Math. Hung.* **71(2)** (2014), 236-242.

15.8. Oscillations in Mertens' product formula for number fields

Speaker: Shehzad Shabbirbhai Hathi (UNSW Canberra)

Time: 16:30 Tue 7 December

Place(s):

Author(s): Shehzad Shabbirbhai Hathi

In 2009, Diamond and Pintz showed that the error term in Mertens' product formula in the classical setting changes sign infinitely often. In this talk, we will discuss its generalisation, that is, subject to certain conditions, the error term in Mertens' product formula for number fields changes sign infinitely often.

15.9. Primes in floor function sets and sequences

Speaker: Randell Heyman (University of New South Wales)

Time: 13:30 Fri 10 December

Place(s):

Author(s): Randell Heyman

Based on work with 4 co-authors I outlined, at the Number Theory Down Under 2019 conference, some reasonably tight bounds on $\sum_{n \leq x} \varphi(\lfloor x/n \rfloor)$. Asymptotic formulas for $\sum_{n \leq x} f(\lfloor x/n \rfloor)$, where f is in certain classes of slower growing arithmetic functions, were also established. I will review papers since then that have established an asymptotic formula in the case $f = \varphi$ and reduced the error terms for other arithmetic functions. There has also been some progress on counting primes in floor function sets and sequences.

15.10. Improving bounds on prime counting functions

Speaker: Daniel Johnston (UNSW Canberra)

Time: 19:00 Tue 7 December

Place(s):

Author(s): Daniel Johnston

The number of primes less than x, denoted $\pi(x)$, is asymptotic to the logarithmic integral $\mathrm{li}(x)$. For several applications in number theory, it is useful to have strong bounds on the difference $|\pi(x)-\mathrm{li}(x)|$. In this talk, we give a survey of existing results on this matter and discuss recent improvements and optimisations. As an application, we apply such results to an inequality of Ramanujan.

15.11. Explicit Estimates for the Residue of the Dedekind zeta-function

Speaker: Ethan Simpson Lee (UNSW Canberra)

Time: 17:00 Tue 7 December

Place(s):

Author(s): Ethan Simpson Lee

In Analytic Number Theory, zeta-functions are important objects, because their zeros and poles can reveal information about primes. In the number fields setting, the Dedekind zeta-function is the zeta-function of choice, so it is important to investigate its properties and estimate its invariants, including the residue of its solitary, simple pole at s=1. In this talk, we explore unconditional and conditional explicit bounds for this residue.

15.12. On a Problem of Lang for Matrix Polynomials

Speaker: Alina Ostafe (University of New South Wales)

Time: 14:30 Fri 10 December

Place(s):

Author(s): Alina Ostafe

In this talk we consider a problem of Lang about finiteness of torsion points on plane rational curves, and discuss some results towards a matrix analogue of this problem, including a full analogue for 2×2 matrices defined over $\mathbb{C}$. We also pose several problems in this direction.

15.13. Pseudorandomness of Kloosterman and Salie Sums

Speaker: Igor Shparlinski (UNSW Sydney)

Time: 14:30 Tue 7 December

Place(s):

Author(s): Igor Shparlinski

We present some old and more recent results which suggest that Kloosterman and Salie sums exhibit a pseudorandom behaviour similar to the behaviour which is traditionally attributed to the Mobius function. In particular, we formulate some analogues of the Chowla Conjecture for Kloosterman and Salie sums. We then describe several results about the non-correlation of Kloosterman and Salie sums between themselves and also with some classical number-theoretic functions such as the Mobius function, the divisor function and the sums of binary digits. Various arithmetic applications of these results will be outlined as well.

15.14. Effective conditional estimates for the argument of ζ on the critical line with applications

Speaker: Aleksander Simonic (University of New South Wales Canberra)

Time: 17:30 Tue 7 December

Place(s):

Author(s): Aleksander Simonic

We provide explicit and conditional (RH) bounds for $S(t)$ and $S_1(t)$. Then we show how to use them to derive explicit and conditional estimates for the Mertens function $M(x)$ and for the number of k-free numbers. If time will permit we are going to describe also possible improvements upon results for $M(x)$.

15.15. Computing Quadratic Integer Relations

Speaker: Matthew Paul Skerritt (RMIT University)

Time: 16:00 Tue 7 December

Place(s):

Author(s): Matthew P. Skerritt

An integer relation for real numbers $x_1, \ldots, x_n$ is a set of integers $a_1, \ldots, a_n$ (not all zero) such that $a_1x_1 + \cdots + a_nx_n = 0$. Such relations may be computed using the LLL algorithm (albeit in a roundabout fashion) or more directly with the PSLQ algorithm. An extension of the concept to relations for complex numbers that consist of Gaussian integers is known and able to be computed by the PSLQ algorithm.

In this talk a further extension wherein the integers making the relation are algebraic integers will be presented. The scope will be restricted to quadratic integers. Methods of computing such relations will be discussed from both a theoretical and practical point of view, including some limitations and challenges.

15.16. On explicit lower bounds for L-functions.

Speaker: Valeriia Starichkova (UNSW Canberra)

Time: 16:30 Wed 8 December

Place(s):

Author(s): Valeriia Starichkova

I would like to talk about our joint work with Mike Mossinghoff and Tim Trudgian https://arxiv.org/abs/2107.09230 . The method to get such an explicit result was described by Louboutin. Louboutin's method involves some non-negative trigonometric polynomials of Dirichlet characters. A priori, these polynomials should satisfy some additional special requirement. We show that this condition is satisfied by all non-negative trigonometric polynomials. Thus, the search for suitable polynomials becomes easier. Its efficiency is raised by the annealing computational programming method.

15.17. An apparent bias? Of course: fake mu's!

Speaker: Timothy Trudgian (UNSW Canberra)

Time: 16:00 Wed 8 December

Place(s):

Author(s): Timothy Trudgian

Why should your favourite sum be positive more often than negative? Perhaps you suspect a bias? Perhaps your sum is suspiciously similar to the Moebius function $\mu(n)$? What can we do with such fake mu's? Come along to find out, and together, we can make arithmetic great again!

This is joint work with Greg Martin (UBC) and Mike Mossinghoff (CCR Princeton).

15.18. Genus 2 Curves in Small Characteristic

Speaker: Lukas Zobernig (The University of Auckland)

Time: 14:00 Fri 10 December

Place(s):

Author(s): Lukas Zobernig

We study genus 2 curves over finite fields of small characteristic. The p-rank f of a curve induces a stratification of the coarse moduli space $\mathcal{M}_2$ of genus-2 curves up to isomorphism. We are interested in the size of those strata for all $f \in \{0, 1, 2\}$. In characteristic 2 and 3, previous results show that the *supersingular* $f = 0$ stratum has size q. We show that for $q = 3^r$, over $\mathbb{F}_q$ the *non-ordinary* $f = 1$ and *ordinary* $f = 2$ strata are of size $q(q-1)$ and $q^2(q-1)$, respectively. We give results found from computer calculations which suggest that these formulas hold for all $p \leq 7$ and break down for $p > 7$.

16. Non-commutative Geometry and Operator Algebras

16.1. Levinson's Theorem as an index pairing

Speaker: Angus Alexander (University of Wollongong)
Time: 18:00 Wed 8 December
Place(s):
Author(s): Angus Alexander

In this talk I will begin by introducing some concepts from mathematical scattering theory, including the wave and scattering operators. I will review some recent work of Kellendonk and Richard, relating scattering theory to index theory and discuss how we can interpret Levinson's Theorem as an index pairing between the class of the scattering operator and an appropriate spectral triple. I will finish by discussing how we may use this viewpoint to compute the index pairing using scattering data.

16.2. Characterising Supermanifolds

Speaker: Lukas Anagnostou (The University of Melbourne)
Time: 15:00 Wed 8 December
Place(s):
Author(s): Lukas Anagnostou

The theory of supermanifolds generalises classical manifolds to those modeled on $\mathbb{Z}_2$-graded geometries. There are two common approaches to studying supermanifolds: one taking a local-coordinate description and the other viewing them as a locally ringed spaces with a structure sheaf of supercommutative algebras. The equivalence of these approaches is not obvious, and often in literature authors will stick entirely to the approach that best suits the work at hand. In this talk we discuss the merits and shortcomings of each, with an emphasis on classification in smooth and holomorphic setting. If time permits, I will also provide a brief discussion of volumes of moduli spaces of super Riemann surfaces.

16.3. Locally equivalent quasifree states and the coarse index

Speaker: Chris Bourne (Tohoku University)
Time: 13:00 Thu 9 December
Place(s):
Author(s): Chris Bourne

Quasifree states of Araki's self-dual CAR algebra provide a convenient framework to study (gapped) ground states of fermionic systems. Using ideas from symmetry protected topological (SPT) phases, I will outline how we can use coarse geometry and the coarse index to provide a characterisation of locally equivalent quasifree ground states, possibly with additional symmetries.

16.4. Commutativity and geometry

Speaker: Ada Masters (None)
Time: 16:30 Wed 8 December
Place(s):
Author(s): Ada Masters

The usual way of generalising the commutative, associative algebras of classical geometry is by considering noncommutative, associative algebras. In this talk, we take the road less traveled by and generalise to commutative, nonassociative algebras. In particular, Jordan algebras are a class of commutative algebras which are closely aligned with associative algebras. A Jordan geometry has associated with it natural differential, Riemannian, and Poisson geometry constructs. Fuzzy geometry is one arena where Jordan algebras are particularly useful. For instance, real functions on the fuzzy 2-sphere have a natural interpretation as a Jordan algebra. Furthermore, the fuzzy 4-sphere can be constructed without a superfluous 2-sphere bundle only in the context of Jordan geometry.

16.5. Perfecting noncommutative topology

Speaker: Alexander Mundey (University of Wollongong)
Time: 13:30 Thu 9 December
Place(s):
Author(s): Alexander Mundey

Gelfand duality underpins noncommutative topology by providing a passage between topological spaces and C*-algebras. For locally compact Hausdorff spaces the translation is more awkward than in the compact case, requiring properness of the maps between spaces. By compactifying the fibres of a continuous map, it is possible to extend it to one which is proper, or with a bit more work, perfect. Using the language of C*-extensions, I will explain how fibrewise compactifications and perfections fit into the established framework of noncommutative topology. I will outline how these constructions can be used to recover Schafhauser's projective limit description of the boundary path space of a topological graph, and how their noncommutative counterparts yield Katsura's direct limit decomposition of the core of a Cuntz-Pimsner algebra.

16.6. Stably finite extensions of rank-2 graph C*-algebras

Speaker: Abraham Ng (University of Wollongong)
Time: 14:00 Thu 9 December
Place(s):
Author(s): Abraham Ng

Thirteen years ago, Evans (2008) computed the K-theory of 2-graph C^*-algebras by using Kasparov spectral sequences. In this talk, we explore an alternative method of computing the same K-theory by using Pimsner—Voiculescu sequences instead. This allows us to have a more concrete description of the maps involved. In particular, given a saturated hereditary subset H of a row-finite 2-graph Λ with no sources, we are interested in the map in K-theory induced by the inclusion $C^*(H\Lambda) \hookrightarrow C^*(\Lambda)$. This is because a result by Spielberg (1988) relates the aforementioned induced map to stable finiteness of the enveloping algebra. The upshot of all this is a sufficient condition for $C^*(\Lambda)$ to be stably finite. This is joint work with Aidan Sims (University of Wollongong) and Astrid an Huef (Victoria University of Wellington).

16.7. AFE property for the Deaconu-Renault groupoid

Speaker: Rafael Rafael Pereira Lima (Victoria University of Wellington)
Time: 18:30 Wed 8 December
Place(s):
Author(s): Rafael Pereira Lima

In the theory of C*-algebras, the AF embeddable property is characterised for graph and k-graph algebras. Using similar ideas from Clark, an Huef and Sims, we find a property that (under certain conditions) describes when the C*-algebra of the Deaconu-Renault groupoid is AF embeddable. The proof uses some technical results on homology groups. In this talk, we will outline some of the ideas.

16.8. The Brauer group for Fell algebras.

Speaker: Nicholas Seaton (University of Wollongong)
Time: 19:30 Wed 8 December
Place(s):
Author(s): Nicholas Seaton

The Dixmier-Douady Theory for continuous trace C^*-algebras provides a cohomological invariant which can track if two C^*-algebras have a spectrum preserving Morita equivalence. In this theory, there is a well defined Brauer group. In 2010, An Huef, Kumjian and Sims generalised this and gave a Dixmier-Douady Theory for Fell algebras. In this talk, we will describe the construction of the Brauer group for Fell algebras.

16.9. Graded KK-groups for graph algebras

Speaker: Aidan Sims (University of Wollongong)
Time: 14:30 Thu 9 December
Place(s):
Author(s): Aidan Sims

For a C^*-algebraist, when presented with a new example of a C^*-algebra, it is more or less a knee-jerk reaction to try to compute its K-theory. In particular, for graph algebras, the K-theory is readily computable and reflects key information about the adjacency matrix of the graph. C^*-algebraic K-theory has a dual theory, K-homology, and both are subsumed in Kasparov's powerful KK-theory, which also allows for distinguishing between different Z_2-gradings of a C^*-algebra; but computing these invariants tends to be less of an automatic reaction. In this talk I will outline computations of graded

K-theory and K-homology groups for gradings of graph algebras determined by $\{0,1\}$-labellings of their edges.

16.10. A generalisation of the spectral theorem for normal operators

Speaker: Alan Stoneham (UNSW Sydney)

Time: 16:00 Wed 8 December

Place(s):

Author(s): Alan Stoneham

A collection of classic results in the spectral theory of operators are the representation theorems for normal operators on Hilbert spaces. A generalisation of this theorem for operators on Banach spaces was established with the theory of well-bounded operators, which are operators that possess a functional calculus for the absolutely continuous functions on some interval [a,b]. Such operators have real spectrum, and adapting this theory to operators with complex spectra has been met with limited success, largely due to complications in candidate definitions of absolute continuity for functions defined on subsets of the complex plane. Over the 2000s, Ashton and Doust developed a new notion of absolute continuity motivated by spectral theory. In this talk, we will discuss some representation theorems of operators which have a functional calculus with respect to Ashton and Doust absolute continuity.

16.11. Witten Genus and Elliptic genera for proper actions

Speaker: Mathai Varghese (The University of Adelaide)

Time: 14:00 Wed 8 December

Place(s):

Author(s): Mathai Varghese

In this paper, we construct for the first time, the Witten genus and elliptic genera on noncompact manifolds with a proper cocompact action by an almost connected Lie group and prove vanishing and rigidity results that generalise known results for compact group actions on compact manifolds. A key tool used is "Dirac Induction" via noncommutative geometry.

16.12. Fell Bundle Models for C*-algebras.

Speaker: Joel Zimmerman (University of Wollongong)

Time: 19:00 Wed 8 December

Place(s):

Author(s): Joel Zimmerman

Kumjian (1986) and Renault (2008) give techniques for constructing from a pair consisting of an abstract C*-algebra and a Cartan subalgebra, an essential groupoid and an associated twist whose twisted groupoid C*-algebra is isomorphic to the original algebra. Applying a well-known correspondence between groupoid twists and Fell bundles, we can view these results as providing a construction of Fell bundle models for abstract C*-algebras where the fibres of the bundle are one dimensional. We will discuss generalising this view of the theory to provide models with more complicated fibres, and discuss how this relates to the problem of generalising the results of Kumjian and Renault to non-essential groupoids.

17. Optimisation

17.1. An augmented subgradient method for nonsmooth DC optimization

Speaker: Adil Bagirov (Federation University Australia)

Time: 14:00 Thu 9 December

Place(s):

Author(s): Adil Bagirov

In this talk, we discuss a method, called an augmented subgradient method, for solving unconstrained nonsmooth difference of convex (DC) optimization problems. At each iteration of this method search directions are found by using several subgradients of the first DC component and one subgradient of the second DC component of the objective function. We also discuss results on the convergence of the method, present numerical results using academic test problems with nonsmooth DC objective functions and compare the proposed method with two general nonsmooth optimization solvers and five solvers specifically designed for unconstrained DC optimization.

17.2. Continuous time approaches to structured convex minimization problems

Speaker: Radu Ioan Bot (University of Vienna)

Time: 19:00 Wed 8 December

Place(s):

Author(s): Radu Ioan Bot

In the first part of the talk we propose a continuous time primal-dual approach to the minimization of a complexly structured convex function involving compositions with linear operators. We prove existence and uniqueness of the trajectory and also that this asymptotically converges to a saddle point of the Lagrangian of the underlying convex minimization problem. In addition, we provide rates for both the violation of the feasibility condition by the ergodic trajectory and the convergence of the objective function value along these ergodic trajectory to its minimal value. Explicit time discretization leads to a numerical algorithm which is a combination of the linearized proximal method of multipliers and the proximal ADMM algorithm.

In the second part of the talk we propose a second order primal-dual dynamical system with asymptotic vanishing term. We show fast convergence of the primal-dual gap, the feasibility measure, and the objective function value along the generated trajectory. We also prove that the primal-dual trajectory asymptotically weakly converges to a primal-dual optimal solution of the underlying minimization problem.

The talk relies on the papers (Boţ, Csetnek, László, JDE, 2020) and (Boţ, Nguyen, JDE, 2021).

17.3. Solving nonlinear binary optimisation with cutting planes

Speaker: Thi Hoa Bui (Curtin University)

Time: 08:30 Wed 8 December

Place(s):

Author(s): Thi Hoa Bui

In this talk, we discuss a general approach based on cutting planes for solving nonlinear (possibly non-convex) binary optimisation problems. The cutting plane method here can be viewed as the discrete analogue of bundle methods. We provide a convergence analysis that yields an upper bound on the number of iterations required. Moreover, using tools from variational analysis, we provide necessary and sufficient dual optimality conditions. As a by-product of these optimality conditions, we show that if the objective function is quasiconvex and the feasible set is defined only with linear constraints, once the optimal solution is first added, the cutting plane method will converge in the next iteration.

17.4. Splitting and projection methods for control-constrained linear-quadratic optimal control problems

Speaker: Bethany Caldwell (University of South Australia)

Time: 16:30 Tue 7 December

Place(s):

Author(s): Professor Regina Burachik, Miss Bethany Caldwell, Associate Professor Yalçın Kaya

Consider a control-constrained linear-quadratic optimal control problem, which is an infinite-dimensional optimisation problem. To solve this problem traditionally we would discretise the problem and solve using finite-dimensional large-scale numerical optimisation techniques. We instead consider the application of projection methods which has shown promising numerical results. In this talk we derive the projection operators for the pure harmonic oscillator and damped harmonic oscillator. We solve these problems by incorporating the projection operators in four splitting and projection-type algorithms: the Method of Alternating Projections, Dykstra's algorithm, Douglas-Rachford algorithm and Aragón Artacho-Campoy algorithm.

17.5. Monotone Operators and Closures Operations for convex sets in XX^*.

Speaker: Andrew Craig Eberhard (RMIT University)

Time: 17:30 Tue 7 December

Place(s):

Author(s): Andrew Craig Eberhard

In the study of monotone operators $M : X \to X^*$ is greatly facilitated via the used of convex function defined on the product of Banach spaces $X \times X^*$ that are minorised by the duality product and make contact there along the graph of the monotone operator. The closure that such representative functions naturally exhibits is that arising in the construction of the Fitzpatrick function and leads us to study $s \times w^*$-closure operations as applied to convex sets in $X \times X^*$. In this talk we discuss some of the inherent topological difficulties involved and how these issue do not arise when X is reflexive or the monotone operator is of dense type. We are lead to discuss a variant of the Banach-Dieudonné theorem as it applies to convex sets in $X \times X^*$ and a new way of studying such closures for convex sets. We ask whether these closures can be sequentially characterised for convex sets and find a super set of reflexive spaces for which this is the case.

17.6. Logic-based Benders' Decomposition for Crew Scheduling in maintenance operation

Speaker: Ponpot Jartnillaphand (Curtin University)

Time: 15:00 Wed 8 December

Place(s):

Author(s): Ponpot Jartnillaphand

The crew scheduling problem in maintenance operations comprises two key parts: (1) scheduling the timings of a set of tasks over a given planning period, and (2)assigning the scheduled tasks to available crews. In this research, we develop an optimisation model for the crew scheduling problem with the objective of maximising the number of all completed jobs subject to various constraints. Like many mathematical models in practice, when dealing with large-scale data, our model faces the curse of dimensionality that challenges cutting-edge optimization solvers, such as IBM CPLEX. To overcome this, we consider a logic-based Benders' decomposition method to improve the overall running time. In this talk, we will discuss about our optimisation model and a decomposition method to tackle the dimensionality challenges.

17.7. A Radius Theorem for Metric Subregularity

Speaker: Alexander Kruger (Federation University Australia)

Time: 16:00 Tue 7 December

Place(s):

Author(s): A. L. Dontchev, H. Gfrerer. A. Y. Kruger, J. V. Outrata

We focus on evaluating the radius of the property of metric subregularity which, in contrast to its siblings, metric regularity, strong regularity and strong subregularity, exhibits a more complicated behaviour under perturbations. We consider three kinds of perturbations: by Lipschitz continuous functions, by semismooth functions, and by smooth functions, obtaining different expressions/bounds for the radius of subregularity, which involve generalized derivatives of set-valued mappings.

References

A. L. Dontchev, H. Gfrerer. A. Y. Kruger, J. V. Outrata. The radius of metric subregularity. Set-Valued Var. Anal. 28 (2020), no. 3, 451-473.

The research was supported by the Australian Research Council, project DP160100854.

17.8. A primal/dual computable approach to improving spiraling algorithms, based on minimizing spherical surrogates for Lyapunov functions

Speaker: Scott Boivin Lindstrom (Curtin University)

Time: 15:00 Thu 9 December

Place(s):

Author(s): Scott Boivin Lindstrom

Optimization problems are frequently tackled by iterative application of an operator whose fixed points allow for fast recovery of locally optimal solutions. Under light-weight assumptions, stability is equivalent to existence of a function—called a Lyapunov function—that encodes structural information about both the problem and the operator. Lyapunov functions are usually hard to find, but if a practitioner had a priori knowledge—or a reasonable guess—about one's structure, they could equivalently tackle the problem by seeking to minimize the Lyapunov function directly. We introduce a class of methods that does this. Interestingly, for certain feasibility problems, circumcentered-reflection method (CRM) is an extant example therefrom. However, CRM may not lend itself well to primal/dual adaptation, for reasons we show. Motivated by the discovery of our new class, we experimentally demonstrate the success of one of its other members, implemented in a primal/dual framework.

17.9. A Primal—Dual Penalty Algorithm for Optimal Control of the Double Integrator

Speaker: Xuemei Liu (University of South Australia)
Time: 17:00 Tue 7 December
Place(s):
Author(s): Regina Burachik, Yalcin Kaya, Xuemei Liu

We propose a duality scheme for solving constrained non-smooth and non-convex optimization problems in a reflexive Banach space. We solve the dual problem (in a Hilbert space) using a deflected subgradient (DSG) algorithm in a general augmented Lagrangian framework. We provide two choices of step-size for the algorithm and establish the convergence results for the primal and dual sequences. We obtain analytical and numerical results for optimal control of the double integrator using our primal—dual framework. In particular, we obtain the exact penalty parameter for the problem in terms of the given boundary points. We also discuss the properties of the optimal control function according to the regions in the plane determined by all possible boundary conditions.

17.10. Fixed-Time Gradient Dynamics with Time-Varying Coefficients for Continuous-Time Optimization

Speaker: Lien Nguyen (RMIT University)
Time: 15:00 Tue 7 December
Place(s):
Author(s): Lien Nguyen

Dynamical systems approach to address the continuous-time optimisation problems has attracted much attention from very early days and become a growing interdisciplinary research area. In this work, we propose fixed-time gradient dynamical systems with time-varying coefficients for continuous-time optimisation. We first investigate the Lyapunov stability conditions that allow us to achieve fixed-time stability of the time-varying dynamical systems. We then use them to deal with continuous-time optimisation problems. We show that under the proposed fixed-time gradient dynamics and by choosing time-varying coefficients, the searching trajectories converge to their optima in fixed-time from any initial points with a very fast rate.

17.11. Convergence of generalized proximal point algorithms

Speaker: Hui Ouyang (University of British Columbia, Okanagan)
Time: 09:00 Thu 9 December
Place(s):
Author(s): Hui Ouyang

We propose a framework of generalized proximal point algorithms associated with a maximally monotone operator and also indicate sufficient conditions on the regularization and relaxation parameters of generalized proximal point algorithms for the equivalence of the boundedness of the sequence of iterations generated by this algorithm and the non-emptiness of the zero set of the maximally monotone operator, and for the weak and strong convergence of the algorithm. Moreover, improvements of our results are illustrated by comparing our results with related known ones.

17.12. Rational activation functions in neural networks with uniform norm based loss functions and its application in classification.

Speaker: Vinesha Peiris (Swinburne University of Technology)
Time: 14:30 Wed 8 December
Place(s):
Author(s): Vinesha Peiris

When the activation function of a simple neural network is one-degree rational function and the loss function is based on the uniform norm, the overall optimisation problem of the network forms a generalised rational approximation problem. Moreover, when the coefficients of the rational activation function are fixed, the weights and the bias of the network become the decision variables of the corresponding optimisation problem. To optimise the decision variables, we suggest using two prominent methods: the bisection method and the differential correction algorithm. We perform numerical experiments on classification problems with two classes. We compare the classification accuracy obtained by the network using the bisection method, differential correction algorithm along with the standard MATLAB toolbox which uses the least square loss function. We show that the choice of the uniform norm-based loss function with rational activation functions and bisection method leads to better classification accuracy.

17.13. Derivative-Free Optimization with Convex Constraints

Speaker: Lindon Roberts (Australian National University)
Time: 18:00 Wed 8 December
Place(s):
Author(s): Lindon Roberts

When optimizing functions which are computationally expensive and/or noisy, gradient information is often impractical to obtain or inaccurate. As a result, so-called "derivative-free" optimization (DFO) methods are a suitable alternative. In this talk, I will show how existing methods for interpolation-based DFO can be extended to nonconvex problems with convex constraints, accessed only through projections. I will introduce a worst-case complexity analysis and show how existing geometric considerations of model accuracy (from the unconstrained setting) can be generalized to the constrained case. I will then show numerical results in the case of nonlinear least-squares optimization. This is joint work with Matthew Hough (University of Queensland and University of Waterloo).

17.14. Invexifying Regularization of Non-Linear Least-Squares Problems

Speaker: Fred Roosta (University of Queensland)
Time: 14:30 Thu 9 December
Place(s):
Author(s): Fred Roosta

We consider regularization of non-convex optimization problems involving a non-linear least-squares objective. By adding an auxiliary set of variables, we introduce a novel regularization framework whose corresponding objective function is not only provably invex, but it also satisfies the highly desirable Polyak–Lojasiewicz inequality for any choice of the regularization parameter. Although our novel framework is entirely different from the classical L_2 regularization, an interesting connection is established for the special case of under-determined linear least-squares. In particular, we show that gradient descent applied to our novel regularized formulation converges to the same solution as the linear ridge-regression problem. Numerical experiments corroborate our theoretical results and demonstrate the method's performance in practical situations as compared to the typical L_2 regularization.

17.15. A convex form that is not a sum of squares

Speaker: James Saunderson (Monash University)
Time: 18:30 Wed 8 December
Place(s):
Author(s): James Saunderson

Every convex homogeneous polynomial (or form) is nonnegative. A natural question is whether every convex form has the stronger property of being a sum of squares. Blekherman has shown that convex forms that are not sums of squares exist via a nonconstructive argument, but until now no explicit examples have been found. In this talk I will discuss an explicit example of a convex form of degree four in 272 variables that is not a sum of squares. The form is related to the Cauchy-Schwarz inequality over the octonions. I will also discuss connections between this question and the quality of sum-of-squares-based relaxations of polynomial optimisation problems over the sphere.

17.16. Approximations in the form of quasilinear functions

Speaker: Nadia Sukhorukova (Swinburne University of Technology)
Time: 13:00 Thu 9 December
Place(s):
Author(s): Nadia Sukhorukova

Rational approximation (approximation by a ratio of two polynomials, that is the basis functions are monomials) and generalised rational approximation (approximation by a ration of two linear forms, basis functions are not limited to monomials) provide flexible and accurate function approximations. The corresponding optimisation problems are quasiconvex and the approximations are quasilinear with respect to the parameters. In this talk, I am going to demonstrate that most results can be extended to the case of approximation by general quasilinear functions. This type of problems appear in a rich variety of applications, including deep learning.

17.17. Nonsmooth DC optimization-based piecewise linear L1-regression

Speaker: Sona Taheri (Royal Melbourne Institute of Technology)

Time: 09:00 Wed 8 December

Place(s):

Author(s): Sona Taheri

In this presentation, I will talk about a novel optimization-based regression method that is robust, in particular, in data sets containing outliers. The regression problem is formulated using the L1-risk function and the set of continuous piecewise linear functions represented as a maximum of minima of linear functions. The objective function in this regression problem is represented as a (difference of convex) DC function and the adaptive piecewise linear regression algorithm is developed to solve it. The proposed algorithm builds the optimal piecewise linear estimates adaptively. More specifically, it constructs the piecewise linear estimator of the regression function starting from a linear function. The auxiliary problems are defined to decide whether the new linear function should be added to the minimum function or to the maximum function as a separate function. This makes the proposed algorithm flexible, and therefore, efficient since it can automatically determine the piecewise linear function estimating the regression function. The auxiliary problems are also applied to generate starting points that are rough approximations to the solution of the piecewise linear regression problem. Some numerical experiments using synthetic and real-world data sets containing outliers will be described.

17.18. Can we do better than the product space?

Speaker: Matthew Tam (The University of Melbourne)

Time: 14:30 Tue 7 December

Place(s):

Author(s): Matthew K. Tam

In this talk, we examine some fundamental limitations of fixed point algorithms for finding a zero in the sum of $n \geq 2$ maximally monotone operators using their resolvents. A common approach to this problem involves reformulating as an equivalent two operator inclusion within an n-fold Cartesian product space and applying the Douglas–Rachford algorithm. In the setting, where each resolvent may only be evaluated once per iteration, we show that any fixed point algorithm is necessarily defined on a d-fold Cartesian product space with $d \geq n-1$. Further, we show this is unimprovable by providing a new family of methods which attain the lower bound. Time permitting, applications in decentralised operator splitting will be discussed.

17.19. Mathematical Foundations of Primal-Dual Algorithms for Convex Optimisation

Speaker: Levent Tuncel (University of Waterloo)

Time: 08:00 Thu 9 December

Place(s):

Author(s): Levent Tuncel

On the one hand, convex optimization problems (minimisation of a convex function over a convex set) possess tremendous mathematical elegance and power. On the other hand, convex optimization problems have found an incredible range of applications in other areas of mathematics and mathematical sciences, including data science, as well as in engineering and beyond. The latter, the success in applications, is fueled by the modelling power of convex optimisation and our ability to solve very large instances of convex optimisation problems (provided simpler algebraic structures or sparsity are present and can be detected efficiently). We will start with a general discussion of utilization of dual problem in convex optimization, have a journey through variable metric methods, self-concordant barrier functions and then finally conclude with reporting some recent work on primal-dual interior-point algorithms.

17.20. Flexible rational approximation for matrix functions

Speaker: Julien Ugon (Deakin University)

Time: 16:00 Wed 8 December

Place(s):

Author(s): Julien Ugon, Vinesha Peiris, Nir Sharon and Nadia Sukhorukova

A rational approximation is a powerful method for estimating functions using rational polynomial functions. Motivated by the importance of matrix function in modern applications and its wide potential, we propose a unique optimization approach to construct rational approximations for matrix function evaluation. In particular, we study the minimax rational approximation of a real function and observe that it leads to a series of quasiconvex problems. This observation opens the door for a flexible method that calculates the minimax while incorporating constraints that may enhance the quality of approximation and its properties. Furthermore, the various properties, such as denominator bounds, positivity, and more, make the output approximation more suitable for matrix function tasks. Specifically, they can guarantee the condition number of the matrix, which one needs to invert for evaluating the rational matrix function. Finally, we demonstrate the efficiency of our approach on several applications of matrix functions based on direct spectrum filtering.

17.21. The Bregman Golden Ratio Algorithm for Min-Max Optimisation

Speaker: Daniel Uteda (The University of Melbourne)

Time: 16:30 Wed 8 December

Place(s):

Author(s): Daniel Uteda

The Variational Inequality Problem (VIP) provides a framework through which many optimisation problems can be solved. However, numerical methods to solve VIPs often require a global Lipschitz assumption, which is quite restrictive. In this talk, we are interested in min-max optimisation of functions with locally Lipschitz gradients. Some methods can be modified to include a backtracking line-search procedure, which then converges under the local Lipschitz condition, but this can quickly add up in the total run-time of the algorithm. Recently, a method called the Golden RAtio ALgorithm (GRAAL) and its adaptive counterpart (aGRAAL) were proposed. The novelty of these methods is in the fully explicit adaptive step size of aGRAAL - which gives convergence results under local Lipschitz assumptions, without the need for backtracking. We present an analogue to this method which uses the Bregman proximal operator. As motivation, we give an example where the proximal step becomes much simpler when using the Kullback-Leibler divergence in place of the standard Euclidean distance. Time-permitting, we will also share some numerical results for the min-power centre problem in Wireless Sensor Networks.

17.22. Finding geodesics joining given points

Speaker: Erchuan Zhang (Edith Cowan University)

Time: 13:30 Thu 9 December

Place(s):

Author(s): Erchuan Zhang

Finding a geodesic joining two given points in a complete path-connected Riemannian manifold requires much more effort than determining a geodesic from initial data. This is because it is much harder to solve boundary value problems than initial value problems. Shooting methods attempt to solve boundary value problems by solving a sequence of initial value problems, and usually need a good initial guess to succeed. In this talk, we propose to find a geodesic by dividing the time interval into several sub-intervals, preferably just enough to enable a good initial guess for the boundary value problem on each subinterval. Then a geodesic joining consecutive endpoints (local junctions) is found by single shooting and junctions are adjusted by Riemannian gradient descent or Newton's method.

This talk is based on joint work with Prof. Lyle Noakes (UWA).

18. Partial Differential Equations: From Theory to Applications

18.1. Isolated singularities for nonlinear elliptic equations with a gradient-dependent nonlinearity

Speaker: Florica Corina Cirstea (The University of Sydney)

Time: 16:00 Wed 8 December

Place(s):

Author(s): Florica Corina Cirstea

In this talk, we will discuss recent developments on the classification of isolated singularities for nonlinear elliptic equations with gradient-dependent nonlinearities and Hardy type potentials. In particular, we shall reveal the critical role played by the fundamental solutions of the elliptic operator in the interaction with the nonlinear part of the equation. This talk is based on joint work with Maria Farcaseanu (The University of Sydney).

18.2. A doubly nonlinear evolution problem involving the fractional p-Laplacian

Speaker: Timothy Allen Collier (The University of Sydney)

Time: 15:00 Wed 8 December
Place(s):
Author(s): Timothy Allen Collier

In this talk I will discuss an evolution problem involving the doubly nonlinear operator, $(-\Delta_p)^s\phi$, given by the fractional p-Laplacian composed with a continuous, strictly increasing function ϕ. We consider existence and uniqueness in the sense of mild solutions in L^1 to the inhomogeneous problem which we use to then obtain regularity of solutions. For example, we find strong solutions, by applying a De Georgi iteration method we obtain $L^q - L^\infty$ decay estimates, and in the homogeneous case we have extinction in finite time. This is based on joint work with Daniel Hauer.

18.3. Free Boundary Problems with a Source Term in n-Space Dimension

Speaker: Yihong Du (University of New England)

Time: 14:30 Tue 7 December
Place(s):
Author(s): Yihong Du

We consider the one phase Stefan problem with a source term, which has been used to describe the spreading of species with the free boundary representing the spreading front. In high space dimension, the regularity of the free boundary is difficult to treat. I will explain how some of the techniques used to treat the classical Stefan problem can be further developed to obtain regularity results for the current problem. I will also discuss the long-time dynamics and reveal some striking differences when the initial range is changed from a bounded domain to certain unbounded domains in R^n, including the existence of families of semi-wave solutions with curved fronts for the latter case.

18.4. Classification of singular solutions to nonlinear elliptic equations with a gradient term

Speaker: Maria Farcaseanu (The University of Sydney)

Time: 13:00 Thu 9 December
Place(s):
Author(s): Maria Farcaseanu

In this talk, we present recent classification results of the behavior near zero for the positive solutions of some nonlinear elliptic equations with singular potentials and gradient-dependent nonlinearities. This is joint work with Florica Cirstea.

18.5. The Fractional Malmheden Theorem

Speaker: Giacomin Giovanni (The University of Western Australia)

Time: 17:00 Tue 7 December
Place(s):
Author(s): Giovanni Giacomin, Serena Dipierro, Enrico Valdinoci

We present a fractional counterpart of the classical result by H.W.Malmheden on the representation of harmonic maps in the Euclidean ball as the average of a linear interpolation of the boundary data. From that we obtain a representation formula for s-harmonic functions as a linear superposition of weighted classical harmonic functions which also entails a new simple proof of the fractional Harnack inequality. This proof also leads to optimal constants for the fractional Harnack inequality in the ball. As a further application we also prove a fractional counterpart for the Schwarz formula for harmonic maps in the two dimensional disc.

18.6. The Dirichlet-to-Neumann operator associated with the 1-Laplacian and evolution problems

Speaker: Daniel Hauer (The University of Sydney)

Time: 19:00 Tue 7 December

Place(s):

Author(s): Daniel Hauer

In this paper, we present the first insights about the Dirichlet-to-Neumann operator in L^1 associated with the 1-Laplace operator or total variational flow operator. This operator is the main object, for example, in studying inverse problems related to image processing, but also admits an important relation to geometry. We show that this operator can be represented by the sub-differential in $L^1 \times L^\infty$ of a convex, homogeneous, and continuous functional on L^1. This is quite surprising since it implies a type of stability or compactness result even though the singular Dirichlet problem governed by the 1-Laplace operator might have infinitely many weak solutions (if the given boundary data is not continuous). As an application, we obtain well-posedness and long-time stability of solutions of a singular coupled elliptic-parabolic initial boundary-value problem.

18.7. Recent regularity theory of optimal transport and applications

Speaker: Jiakun Liu (University of Wollongong)

Time: 08:30 Thu 9 December

Place(s):

Author(s): Jiakun Liu

In this talk, we first give a brief introduction to the optimal transport problem, and then introduce some of our recent results on the global regularity theory. In addition, we will include an example of application to the reconstruction problem in cosmology. These are joint works with Shibing Chen (USTC) and Xu-Jia Wang (ANU), and with Gregoire Loeper (Monash).

18.8. Calculating Tsunami Waves using Complex Analysis

Speaker: Michael Meylan (The University of Newcastle)

Time: 14:30 Thu 9 December

Place(s):

Author(s): Michael Meylan and Santu Das

The devastating impact of Tsunamis is well known. Rapid movements of the seafloor generate them, and we solve the problem using a double Fourier/Laplace transform which we invert using residue theory in space and calculate numerically in time. The results allow us to calculate the effect of ocean compressibility, which plays a significant role at the time and spatial scales of a Tsunami. In particular, we can calculate the acoustic gravity waves that propagate ahead of the Tsunami and have been proposed as a method for early detection.

18.9. Asymptotic behaviour of biharmonic heat equations on unbounded domains

Speaker: Jonathan Mui (The University of Sydney)

Time: 14:30 Wed 8 December

Place(s):

Author(s): Jonathan Mui

It is well-known that the heat equation $u_t - \Delta u = 0$ on $\mathbb{R}^n$ enjoys a *positivity preserving property*: if the initial datum u_0 is positive, then the solution $u = u(t,x)$ satisfies $u(t,x) > 0$ for all $t > 0$. On the other hand, one cannot expect the positivity preserving property to hold for higher-order elliptic operators. Nevertheless, it seems that positivity is 'almost' preserved in some sense. Gazzola and Grunau have shown that the biharmonic heat equation $u_t + (-\Delta)^2 u = 0$ on $\mathbb{R}^n$ displays *local eventual positivity*. Roughly speaking, this means that given positive initial datum u_0, for every compact set $K \subset \mathbb{R}^n$ there exists a time $T > 0$ such that the solution $u = u(t,x)$ is positive on K for all $t \geq T$. Intuitively, this phenomenon occurs as a result of the oscillatory behaviour of the fundamental solution, and so far, local eventual positivity for these equations has been studied via explicit analysis of the biharmonic heat kernel.

On the other hand, from an abstract perspective, solutions to evolution equations may be studied via an appropriate semigroup of linear operators. The study of positive operator semigroups is by now a classic topic. However, a systematic theory of *eventually positive semigroups* in infinite dimensions was first developed systematically by Daners, Glück and Kennedy in 2016. The results of these papers are effective in particular for studying positivity in elliptic or parabolic problems on bounded domains, where the associated operator has a simple principal eigenvalue. For this reason, however, the methods cannot be adapted to evolution equations on unbounded domains.

We study the asymptotic behaviour of solutions to the biharmonic heat equation on $\mathbb{R}^n$ as well as on 'infinite cylinders' of the form $\mathbb{R} \times \Omega$, where $\Omega \subset \mathbb{R}^n$ is a bounded domain with smooth boundary. As a consequence of our results, we recover the local eventual positivity of solutions qualitatively (i.e. without use of explicit heat kernels), and for a larger class of initial data than was previously considered. The analysis on the infinite cylinder uses various properties of a family of fourth-order eigenvalue problems, which may be of independent interest.

18.10. The prescribed cross curvature problem

Speaker: Artem Pulemotov (The University of Queensland)

Time: 16:00 Tue 7 December

Place(s):

Author(s): Artem Pulemotov

Chow and Hamilton introduced the notion of cross curvature and the associated geometric flow in 2004. Several authors have built on this work to study the uniformisation of negatively curved manifolds, Dehn fillings, and other topics. Hamilton conjectured that it is always possible to find a metric with given positive cross curvature on the three-sphere and that such a metric is unique. We will discuss several results that support the existence portion of this conjecture. Next, we will produce a counterexample showing that uniqueness fails in general. Joint work with Timothy Buttsworth (The University of Queensland).

18.11. On an overdetermined problem involving the fractional Laplacian

Speaker: Jack Thompson (The University of Western Australia)

Time: 14:00 Wed 8 December

Place(s):

Author(s): Jack Thompson

Overdetermined problems are a type of boundary value problem where 'too many' conditions are imposed on the solution. In general such a problem is ill-posed so the main objective is to classify sets in which the problem is well-posed. A classical result due to J. Serrin says that a bounded domain in $\mathbb{R}^n$ that admits a function with constant Laplacian, zero Dirichlet data, and constant Neumann data must be a ball.

We consider a semi-linear generalisation of Serrin's problem driven by the fractional Laplacian where the value of the solution is prescribed on hyperplane parallel to the boundary. We prove that the existence of a non-negative solution forces the region to be a ball. The proof relies on a new Hopf-type lemma. We also discuss some further related results. This is joint work with S. Dipierro, G. Poggesi, and E. Valdinoci.

18.12. Regularity of free boundary for the Monge-Ampere obstacle problem

Speaker: Xu-Jia Wang (Australian National University)

Time: 13:30 Thu 9 December

Place(s):

Author(s): Xu-Jia Wang

We consider the regularity of free boundaries in the Monge-Ampere obstacle problem, which is the Monge-Ampere counterpart of the classical free boundary problem. By the Legendre transform, the problem can be changed to a singular elliptic equation. Using the polar coordinates and by a partial Legendre transform, we obtain the C^2 regularity by a blow-up argument. The higher regularity can be obtained by establishing a weighted $W^{2,p}$ estimate for the singular elliptic equation.

18.13. On the p-elastic flow

Speaker: Glen Edward Wheeler (University of Wollongong)

Time: 18:00 Wed 8 December

Place(s):

Author(s): Glen Edward Wheeler

In this talk I describe recent joint work with Shinya Okabe (Tohoku U) on the L^2-gradient flow for the modified p-elastic energy defined on planar closed curves. Using a minimising movements technique we prove the existence of global-in-time weak solutions with p greater than or equal to 2 for initial curves in the energy space. In the special case where p equals 2, we prove the existence of unique global-in-time solutions to the flow with and obtain their subconvergence to an elastica.

18.14. On the Chen flow

Speaker: Valentina-Mira Wheeler (University of Wollongong)
Time: 08:00 Wed 8 December
Place(s):
Author(s): Valentina-Mira Wheeler

In this talk we give survey what is currently known for Chen's flow, and discuss some very recent results. Chen's flow is the biharmonic heat flow for immersions, where the velocity is given by the rough Laplacian of the mean curvature vector. This operator is known as Chen's biharmonic operator and the solutions to the elliptic problem are called biharmonic submanifolds. The flow itself is very similar to the mean curvature flow (this is essentially the content of Chen's conjecture), however proving this requires quite different strategies compared to the mean curvature flow. We focus on results available in low dimensions – curves, surfaces, and 4-manifolds. We provide characterisations of finite-time singularities and global analysis. The case of curves is particularly challenging. Here we identify a new shrinker (the Lemniscate of Bernoulli) and use some new observations to push through the analysis. Some numerics is also presented. The work reported on in the talk is in collaboration with Yann Bernard, Matthew Cooper, Phil Schrader and Glen Wheeler.

19. Probability Theory and Stochastic Processes

19.1. Parisian ruin with random deficit-dependent delays for spectrally negative Lévy processes

Speaker: Kostya Borovkov (The University of Melbourne)
Time: 16:00 Fri 10 December
Place(s):
Author(s): Duy Phat Nguyen, Konstantin Borovkov

We consider an interesting natural extension to the Parisian ruin problem under the assumption that the risk reserve dynamics are given by a spectrally negative Lévy process. The distinctive feature of this extension is that the distribution of the random implementation delay windows' lengths can depend on the deficit at the epochs when the risk reserve process turns negative, starting a new negative excursion. This includes the possibility of an immediate ruin when the deficit hits a certain subset. In this general setting, we derive a closed-from expression for the Parisian ruin probability and the joint Laplace transform of the Parisian ruin time and the deficit at ruin.

19.2. Towards a self-contained theory for stochastics in the complex plane

Speaker: Robert Cantwell (University of New South Wales)
Time: 15:00 Wed 8 December
Place(s):
Author(s): Robert Cantwell, Gery Geenens and Pierre Lafaye de Micheaux

Data represented as complex numbers arise in numerous applied fields such as electrical engineering, neuroscience, geophysics and meteorology. Proper statistical analysis of such data is conditional on a fully-fledged theory of probability and random variables on $\mathbb{C}$. Yet, to date, most of the available theory has been derived by simply translating concepts and notation from $\mathbb{R}^2$ to $\mathbb{C}$ via the Cartesian decomposition of a complex number. Such theory based on $\mathbb{R}^2$ inherently overlooks the complex multiplication, the availability of which often being the motivating reason to work in $\mathbb{C}$ in the first place. This work initiates a self-contained theory for complex random variables, making the most of the field structure of $\mathbb{C}$. In particular, in this talk we will illustrate the power of our approach by revisiting the Mellin transform for complex random variables given by Kotlarski (1965). Introducing a new concept — the principal expectation — we derive an explicit inversion formula unlocking closed-form expressions for the distribution of powers or products of complex random variables (for which there is no $\mathbb{R}^2$ equivalent).

References:
Kotlarski, I. (1965). On the generalized Mellin transform of a complex random variable and its applications. The Annals of Mathematical Statistics, 36(5):1459–1467.

19.3. A bivariate Laguerre expansions approach for joint ruin probabilities in a two-dimensional insurance risk process

Speaker: Eric C.K. Cheung (UNSW Sydney)
Time: 15:00 Fri 10 December
Place(s):
Author(s): Eric C.K. Cheung

In this paper, we consider a two-dimensional insurance risk model where each business line faces not only stand-alone claims but also common shocks that induce dependent losses to both lines simultaneously. The joint ruin probability is analyzed, and it is shown that under certain model assumptions it can be expressed in terms of a bivariate Laguerre series. For computational purposes, the bivariate Laguerre series needs to be truncated, and the corresponding Laguerre coefficients can be obtained through a system of linear equations. The computational procedure is easy to implement, and our numerical examples illustrate its excellent performance. The results are also applied to address a related capital allocation problem. This part is joint work with Hansjoerg Albrecher, Haibo Liu and Jae-Kyung Woo.

19.4. On the distribution of terminal wealth under dynamic mean-variance optimal investment strategies

Speaker: Duy-Minh Dang (University of Queensland)
Time: 14:30 Wed 8 December
Place(s):
Author(s): Pieter M. van Staden, Duy-Minh Dang, Peter A. Forsyth

We compare the distributions of terminal wealth obtained from implementing the optimal investment strategies associated with the different approaches to dynamic mean-variance (MV) optimization available in the literature. This includes the pre-commitment MV (PCMV) approach, the dynamically optimal MV (DOMV) approach, as well as the time-consistent MV approach with a constant risk aversion parameter (cTCMV) and wealth-dependent risk aversion parameter (dTCMV), respectively. For benchmarking purposes, a constant proportion (CP) investment strategy is also considered. To ensure that terminal wealth distributions are compared on a fair and practical basis, we assume that an investor, otherwise agnostic about the philosophical differences of the underlying approaches to dynamic MV optimization, requires that the same expected value of terminal wealth should be obtained regardless of the approach. We present first-order stochastic dominance results proving that for wealth outcomes below the chosen expected value target, the cTCMV strategy always outperforms the DOMV strategy, and an appropriately chosen CP strategy always outperforms the dTCMV strategy. We also show that the PCMV strategy results in a terminal wealth distribution with fundamentally different characteristics than any of the other strategies. Finally, our analytical results are very effective in explaining the numerical results currently available in the literature regarding the relative performance of the various investment strategies.

19.5. Asymptotics of running maxima for phi-subgaussian random double arrays

Speaker: Illia Donhauzer (La Trobe University)
Time: 15:00 Tue 7 December
Place(s):
Author(s): Illia Donhauzer

The talk is about the running maxima functionals of double arrays of phi-subgaussian random variables. Asymptotics of positive and negative parts of running maxima is studied. Different limit theorems and Strong laws of large numbers for positive and negative parts of running maxima will be presented as well as rates of convergences. The main results are specified for various important particular scenarios and classes of phi-subgaussian random variables.

19.6. Precise Local Estimates for Hypoelliptic Differential Equations driven by Fractional Brownian Motion

Speaker: Xi Geng (The University of Melbourne)

Time: 13:00 Thu 9 December

Place(s):

Author(s): Xi Geng

In this talk, we study stochastic differential equations driven by fractional Brownian motion under the framework of rough path theory. Under a hypoellipticity condition, it was well-known that the solution admits a smooth density function. We obtain a sharp local estimate on the associated control distance function and a sharp local lower estimate on the density of the solution. This is based on joint work with Cheng Ouyang (UIC) and Samy Tindel (Purdue).

19.7. A class of non-reversible hypercube long-range random walks and Bernoulli autoregression

Speaker: Robert Charles Griffiths (Monash University)

Time: 14:30 Thu 9 December

Place(s):

Author(s): Robert Charles Griffiths

A class of long-range random walks on the hypercube $\{0, 1\}^N$ has a local property that the distribution of a subset of coordinates at time $t+1$ only depends on the same coordinates at time t. These random walks have an expression as Bernoulli vector autoregression models. If the coordinates of the random walk are exchangeable distributed then the scaled Hamming distance from zero has a limit distribution as $N \to \infty$ of an AR(1) series. This is joint research with Andrea Collevecchio.

19.8. Solution of a stochastic Landau-Lifshitz-Slonczewski equation

Speaker: Chunxi Jiao (The University of Sydney)

Time: 14:00 Thu 9 December

Place(s):

Author(s): Beniamin Goldys, Chunxi Jiao, Kim-Ngan Le

We study a stochastic Landau-Lifshitz-Slonczewski equation on the real line with one-dimensional noise. We show that there exists a pathwise unique solution to this equation for small noises and discuss the regularity of the solution. The proof is based on a discrete approximation followed by a quadratic interpolation with some uniform estimates, and we adapt arguments in Brzeźniak, Goldys and Jegaraj (2012) for convergence results.

19.9. Numerical schemes for jump-extended Constant-Elasticity-of-Variance (CEV) process

Speaker: Libo Li (University of New South Wales)

Time: 17:00 Fri 10 December

Place(s):

Author(s): Libo Li

We propose a positivity-preserving implicit numerical scheme for the jump-extended Cox-Ingersoll-Ross (CIR) process and Constant-Elasticity-of-Variance (CEV) process, where the jumps are governed by a compensated spectrally positive alpha-stable Levy process for alpha in (1, 2). This class of models has first been studied in the context of continuous branching processes with interaction and/or immigration, and in this class, a model has been introduced to mathematical finance for modeling sovereign interest rates and the energy market.

19.10. On Markov chain approximations for computing boundary crossing probabilities of diffusion processes

Speaker: Vincent Liang (The University of Melbourne)

Time: 16:00 Wed 8 December

Place(s):

Author(s): Vincent Liang, Konstantin Borovkov

We propose a discrete time discrete space Markov chain approximation with a Brownian bridge correction for computing curvilinear boundary crossing probabilities of a general diffusion process. The boundary non-crossing probability of the diffusion process is approximated by an n-product of sub-stochastic transition matrices. For broad classes of curvilinear boundaries and diffusion processes, we prove the convergence of the constructed approximations with Brownian bridge corrections to the boundary crossing probabilities for the process. Numerical results indicate that the rate of convergence for the proposed approximations with Brownian bridge correction is $O(n^{-2})$, where n is the number of time steps.

19.11. The expected degree distribution in transient duplication divergence models

Speaker: Tiffany Y. Y. Lo (The University of Melbourne)

Time: 16:00 Tue 7 December
Place(s):
Author(s): Tiffany Y. Y. Lo

We study the expected degree distribution of a randomly chosen vertex in a duplication-divergence graph, under a variety of different generalisations of the basic model of Bhan, Galas, Dewey (2002) and Vázquez, Flammini, Maritan and Vespignani (2003). In this talk, we pay particular attention to what happens when a non-trivial proportion of the vertices have large degrees in the basic model, establishing a central limit theorem for the logarithm of the degree distribution. Our approach, as in Hermann and Pfaffelhuber (2021) and Jordan (2018), relies heavily on the analysis of related birth-catastrophe processes. This is joint work with A.D. Barbour.

19.12. On the probability of fast exits and long stays of a planar Brownian motion in simply connected domains

Speaker: Greg Markowsky (Monash University)

Time: 14:00 Fri 10 December
Place(s):
Author(s): Greg Markowsky

Let T(D) denote the first exit time of a planar Brownian motion starting at 0 from a domain D. A question which has interested a number of researchers is as follows: in what way does the distribution of reflect the geometry of D? Given two simply connected planar domains U and W both containing 0, I will discuss cases in which we are more likely to have fast exits (meaning P(T(U) ¡ t) ¿ P(T(W) ¡ t) for t small) from U than from W, or long stays (meaning P(T(U)¿ t) ¿ P(T(W) ¿ t) for t large). Together with coauthors, we have proved several results on these questions. In particular, we have shown that the primary factor in the probability of fast exits is the proximity of the boundary to the origin, while for long stays an important factor is the moments of the exit time. The complex analytic theory that motivated our inquiry is also discussed. Based on joint work with Demetrios Betsakos and Maher Boudabra

19.13. Variance Reduction for Large Matrix Computations

Speaker: Anant Mathur (UNSW Sydney)

Time: 17:00 Tue 7 December
Place(s):
Author(s): Anant Mathur, Zdravko Botev, and Sarat Moka

In this talk we provide insights into existing variance reduction methods for estimating the entries of large matrices. Popular methods do not exploit the reduction in variance that is possible when the matrix is factorized. We show how computing the square root factorization of the matrix can achieve in some important cases arbitrarily better stochastic performance. In addition, we describe a factorized estimator for the trace of a product of matrices. Numerical experiments suggest that the estimator can be significantly more efficient on certain problems of estimating the log-likelihood of a Gaussian process.

19.14. Dominating stochastic patch occupancy models by independent patches

Speaker: Ross McVinish (The University of Queensland)

Time: 16:30 Wed 8 December
Place(s):
Author(s): Ross McVinish

Stochastic patch occupancy models are discrete time Markov chains on $\{0, 1\}^n$ used to model the presence or absence of a population in a network of habitat patches. This model is compared to a collection of n independent Markov chains on $\{0, 1\}$, which we call the independent patches model. We show that the stochastic patch occupancy model is smaller in the lower orthant order than the independent patches model. This result extends a result by Allen (2008) and Simon and Kiss (2013) showing expectations of the stochastic logistic model are bounded by the deterministic logistic model.

19.15. Graph Coloring via Partial Rejection Sampling

Speaker: Sarat Babu Moka (Macquarie University)

Time: 15:00 Thu 9 December
Place(s):
Author(s): Sarat Babu Moka

Generating a random proper node colouring of an undirected graph, so that the distribution of the resulting colouring is perfectly uniform over the set of all proper colourings, is a challenging problem. All the existing methods for addressing this problem are sequential in nature. Partial rejection sampling is an emerging perfect sampling technique that allows parallelization while reducing the computational complexity by minimizing the random variables generated for running the algorithm. Unfortunately, the partial rejection sampling method does not apply directly to the graph colouring problem. In this work, we introduce a novel perfect sampling framework for graph colouring via an indirect application of partial rejection sampling. To the best of our knowledge, this is the first parallelizable method for graph colouring.

19.16. Mean-field bounds for Poisson-Boolean percolation

Speaker: Stephen Muirhead (The University of Melbourne)

Time: 17:30 Tue 7 December
Place(s):
Author(s): Stephen Muirhead

We establish the mean-field bounds $\gamma \geq 1$, $\delta \geq 2$ and $\triangle \geq 2$ on the critical exponents of the Poisson-Boolean continuum percolation model under a mild moment condition on the radii. While these bounds are classical for Bernoulli percolation, for continuum percolation they were previously known only in the special case of fixed radii (in the case of γ), or not at all (in the case of δ and $\triangle$). We deduce these as consequences of the mean-field bound $\beta \leq 1$, recently established by Duminil-Copin, Raoufi and Tassion under the same moment condition on the radii, using a relative entropy method that we introduced in previous work. Joint work with Vivek Dewan.

19.17. Fractional SPDE for Random Tangent Fields on the Sphere

Speaker: Andriy Olenko (La Trobe University)

Time: 13:30 Thu 9 December
Place(s):
Author(s): Andriy Olenko

We will discuss a fractional stochastic partial differential equation (SPDE) to model the evolution of a random tangent vector field on the unit sphere. The SPDE is governed by a fractional diffusion operator to model the Levy-type behaviour of the spatial solution, a fractional derivative in time to depict the intermittency of its temporal solution, and is driven by vector-valued fractional Brownian motion on the unit sphere to characterize its temporal long-range dependence. The solution to the SPDE is presented in the form of the Karhunen-Loeve expansion in terms of vector spherical harmonics. Its covariance matrix function is established as a tensor field on the unit sphere that is an expansion of Legendre tensor kernels. The variance of the increments and approximations to the solutions are studied and convergence rates of the approximation errors are given. It is demonstrated how these convergence rates depend on the decay of the power spectrum and variances of the fractional Brownian motion.

The talk is based on joint results with V.V.Anh (Swinburne University of Technology) and Y.G.Wang (Max Planck Institute for Mathematics) published in

V.V.Anh, A.Olenko and Y.G.Wang. Fractional stochastic partial differential equation for random tangent fields on the sphere. Theor. Probability and Math. Statist. 104 (2021), 3-22. https://doi.org/10.1090/tpms/1142

19.18. Critical parameter configurations of polynomials of a random variable

Speaker: ZHIHAO QIAO (The University of Queensland)

Time: 16:30 Tue 7 December

Place(s):

Author(s): Vladimir V. Ejov, Jerzy A. Filar and Zhihao Qiao

We consider $\vec{\varepsilon}-$perturbed polynomials $h(x, \vec{\varepsilon})$ with real coefficients that are themselves polynomials of parameters comprising $\vec{\varepsilon}$. In applications where the variable x is uncertain and best modelled by a random variable X, the parametric properties of the $\vec{\varepsilon}-$perturbed polynomial become interesting. In particular, for some values of $\vec{\varepsilon}$, the entire graph of $h(x, \vec{\varepsilon})$, as a function of variable x, may lie completely below (or above) the $x - axis$. Such a situation may constitute a high-risk and hence deserves deeper analysis.

We approach this problem by defining a measure of risk as $R(\vec{\varepsilon}) := \mathbb{P}(h(X, \vec{\varepsilon}) < 0)$ and analysing its behaviour in the $\vec{\varepsilon}$ parameter space. We note that this, rather general, formulation includes the threshold risk of the form $\mathbb{P}(h(X) < \delta(\vec{\varepsilon}))$, where $\delta(\vec{\varepsilon})$ denotes a threshold. The critical parameter configurations are defined as those points in the $\vec{\varepsilon}-$space where $R(\vec{\varepsilon})$ is not Lipschitz continuous. In the vicinity of such points, small changes in parameters may result in rapid changes in the risk.

In the case, where $\vec{\varepsilon}$ is $1-$dimensional, a complete characterisation of candidate risk critical points has recently been obtained in terms of the zeroes of the discriminant of the perturbed polynomial. However, the case where there are two or more parameters is more challenging. We demonstrate that in addition to the above algebraic variety, we also need to consider the varieties induced by the zeroes of the partial derivatives of the discriminant with respect to the entries of $\vec{\varepsilon}$. The intersections within this set of varieties contain the relevant critical parameter configurations.

19.19. Gaussian process approximation using Stein's method, with applications to queues

Speaker: Nathan Ross (The University of Melbourne)

Time: 13:00 Fri 10 December

Place(s):

Author(s): Nathan Ross

Gaussian processes are used as limits or approximations in a wide variety of application areas, such as finance and queuing. In this talk, we discuss a general approach via Stein's method to bound the error when approximating càdlàg random processes by a real continuous Gaussian process. For processes that are representable as integrals of a certain general form against an underlying point process, the bound is in terms of couplings of the original process to processes generated from the reduced Palm measures associated with the point process. We apply the approach to some GI/GI/Infinity queues in the "heavy traffic" regime.
Based on joint work with A. D. Barbour and Guangqu Zheng

19.20. Maximum likelihood estimation for a general mixture of Markov jump processes

Speaker: Budhi Surya (Victoria University of Wellington)

Time: 14:30 Fri 10 December

Place(s):

Author(s): Budhi Surya

We estimate a general mixture of Markov jump processes. The key novel feature of the proposed mixture is that the transition intensity matrices of the Markov processes comprising the mixture are entirely unconstrained. The Markov processes are mixed with distributions that depend on the initial state of the mixture process. The new mixture is estimated from its continuously observed realizations using the EM algorithm, which provides the maximum likelihood (ML) estimates of the mixture's parameters. We derive the asymptotic properties of the ML estimators. For finite samples, we obtain the standard errors of the estimates of the mixture's parameters by employing Louis' (1982) general formula for the observed Fisher information matrix. Simulation study verifies the estimates' accuracy and confirms the consistency and asymptotic normality of the estimators. The developed methods are applied to a medical dataset, for which the likelihood ratio test rejects the constrained mixture in favor of the proposed unconstrained one. This application exemplifies the usefulness of a new unconstrained mixture for identification and characterization of homogeneous subpopulations in a heterogeneous population.

In joint work with Halina Frydman of New York University Stern School of Business.

19.21. Pricing Defaultable Bonds and Credit Derivatives in the Presence of Shock Risk and Unpredictable Recovery

Speaker: Qihe Tang (University of New South Wales)

Time: 14:00 Wed 8 December

Place(s):

Author(s): Qihe Tang

Consider a defaultable bond whose payoff is contingent on the occurrence of a default event. Suppose that the financial market is vulnerable to shock risk, which has impacts on the default intensity, the risk-free interest rate, the reference rate, and the regime switching of the market state. Further suppose that the recovery rate in the event of default contains an exogenous (hence, unpredictable) component in addition to its link to the market performance until default. Thus, our work exhibits two features: the shock risk, which captures profound impacts of exogenous shock events on all sides of the market; the unpredictable component, which is embedded in the recovery rate to further captures uncertainty in the current world of complexity. Assuming that the default intensity, the interest rate, and the reference rate jointly follow a general three-dimensional jump-diffusion process with coefficients governed by the regime of the market, we develop a risk-neutral pricing measure which prices the aforementioned various risk sources in an integrated manner. This pricing framework is directly applicable to other credit derivatives under exogenous shock risk and with unpredictable recovery.

This talk is based on a joint work with Haibo Liu.

19.22. Multitype branching process with nonhomogeneous Poisson and contagious Poisson immigration

Speaker: jae kyung woo (University of New South Wales)

Time: 16:30 Fri 10 December

Place(s):

Author(s): Landy Rabehasaina, Jae Kyung Woo

In this talk, we consider a multitype branching process where immigrants arrive according to a nonhomogeneous Poisson or a contagious Poisson process (both processes are formulated as a nonhomogeneous birth process with an appropriate choice of transition intensities). We show that the normalized numbers of objects of the various types alive at time t for supercritical, critical, and subcritical cases jointly converge in distribution under those two different arrival processes. This is joint work with Landy Rabehasaina.

19.23. Geometric sums, size biasing and zero biasing

Speaker: Aihua Xia (The University of Melbourne)

Time: 14:30 Tue 7 December

Place(s):

Author(s): Qingwei Liu and Aihua Xia

The geometric sum plays a significant role in risk theory and reliability theory [Kalashnikov, V. V. (1997)] and a prototypical example of the geometric sum is Rényi's theorem [Rényi, A. (1956)] saying a sequence of suitably parameterised geometric sums converges to the exponential distribution. There is extensive study of the accuracy of exponential distribution approximation to the geometric sum but there is little study on its natural counterpart of gamma distribution approximation to negative binomial sums. In this talk, we show that a gamma distribution can be uniquely characterised by its two most popular distributional transformations: its size biasing equals its zero biasing. We combine this characterisation with Stein's method to establish simple bounds for gamma distribution approximation. This talk is based on a joint work with Qingwei Liu.

20. Representation Theory

20.1. Arithmetic geometry of characters stacks and their E-polynomials

Speaker: Nick Bridger (University of Queensland)
Time: 14:30 Wed 8 December
Place(s):
Author(s): Nick Bridger

To a compact Riemann surface and a reductive group there is an associated character stack. For over a decade now representation theory has played a significant role in understanding the topology of the associated complex character stack. This in large part due to a theorem of Katz, which roughly says if a variety admits a point counting polynomial then this determines the complex variety's Deligne–Serre polynomial. We determine the point counting polynomial of the character stack, and find that its determined by available information associated to the finite reductive group. The key ingredients here are Lusztig's Jordan decomposition of irreducible characters, the classification of unipotent characters, and a classification of centralisers of semisimple elements. In this talk we explain how these works combine in order to determine the point counting polynomial of the character stack. This is joint work with Masoud Kamgarpour.

20.2. Unimodality of Bruhat intervals

Speaker: Gaston Burrull (The University of Sydney)
Time: 17:00 Tue 7 December
Place(s):
Author(s): Gaston Burrull

Let b_i be the number of i-dimensional cells of a "nicely" stratified variety X. It was conjectured those numbers behave in a unimodal way, i.e., they increase with i, reach a peak, and then decrease. However, this is false for a Schubert variety in the Grassmannian of 4-planes in $\mathbb{C}^{12}$.

Let W be an affine Weyl group with length function ℓ. Let W_f be its corresponding finite Weyl group. I will consider the set ${}^fW = W_f\backslash W$ of minimal length right W_f-coset representatives of W. Let $X = X(w)$ denote the Schubert variety associated with an element w in ${}^fW$. Here the b_i's correspond to the number of elements of length $i/2$ in the Bruhat interval $[e, w] \subset {}^fW$.

I believe that the unimodality of the b_i's might be true here. I checked some interesting examples using SageMath. I will also show some geometric visualizations in ranks 2 and 3.

20.3. Principal subspaces of standard modules of affine Lie algebra of type $G_2^{(1)}$

Speaker: Marijana Butorac (University of Rijeka)
Time: 08:30 Wed 8 December
Place(s):
Author(s): Marijana Butorac

We consider principal subspaces $W_{L(\Lambda)}$ of standard modules $L(\Lambda)$ with the rectangular highest weight, that is, Λ is of the form $k_0\Lambda_0 + k_2\Lambda_2$, where Λ_2 denotes the fundamental weight of level one and $k_0, k_2 \geq 1$, in the case of affine Lie algebra of type $G_2^{(1)}$. By using the theory of vertex operator algebras, we find combinatorial bases of principal subspaces in terms of quasi-particles. From quasi-particle bases, we obtain characters of principal subspaces.

20.4. Hecke category actions via Smith–Treumann theory

Speaker: Joshua Ciappara (The University of Sydney)
Time: 16:30 Tue 7 December
Place(s):
Author(s): Joshua Ciappara

The goal for this talk will be to introduce Smith–Treumann theory as a tool for proving the categorical conjecture of Riche–Williamson. This conjecture concerns an action of the Hecke category by wall-crossing functors on the principal block of an algebraic group in positive characteristic. After recalling some algebraic preliminaries (including a description of the Hecke category), we will state the conjecture in full and outline its implications for representation theory. To conclude, we will sketch a proof of the conjecture using constructible sheaves and Smith–Treumann theory, commenting on further work in progress if time permits.

20.5. Acting by the Long Cycle on the Kazhdan-Lusztig Basis
Speaker: Martin Gossow (The University of Sydney)
Time: 15:00 Wed 8 December
Place(s):
Author(s): Martin Gossow

The irreducible representations of the symmetric group can be equipped with an important basis, called the Kazhdan-Lusztig basis, which is indexed by standard tableaux of a particular shape. It is an important problem in algebraic combinatorics to determine the action of permutations on this basis. In the case when the shape of the tableaux are rectangular, it was determined by Rhoades (2010) that the action of the long cycle $c = (1\ 2\ \cdots\ n)$ on these basis elements is given by the jeu-de-taquin promotion operator up to sign.

We present a generalisation of this result in two directions. Firstly, we prove that the action of the long cycle has a visible connection to the promotion operator, even when the shape of the tableaux are arbitrary. Secondly, we greatly enlarge the collection of permutations for which such a connection exists. A key construction in our approach is a novel proof of the branching rule over the symmetric group, which elucidates a specific combinatorial interaction with the Kazhdan-Lusztig basis. This is based on joint work with Oded Yacobi.

20.6. Cluster algebras and mirror symmetry for flag varieties
Speaker: Ian Le (Australian National University)
Time: 08:00 Wed 8 December
Place(s):
Author(s): Ian Le

I will begin by outlining the philosophy of why cluster structures appear in the study of mirror symmetry for flag varieties. I will explain how this helps in constructing the potentials for mirrors to flag varieties, as in recent work of Marsh and Rietsch. I will end by describing a conjectural approach to proving homological mirror symmetry for flag varieties. This is joint work with Benjamin Gammage.

20.7. q-rational numbers and stability conditions on the A_2 quiver
Speaker: Anthony Licata (Australian National University)
Time: 15:00 Tue 7 December
Place(s):
Author(s): Anthony Licata

Moduli spaces of stability conditions are of interest in several mathematical areas, one of which is group theory: if a group G acts on a triangulated category T by autoequivalences, then G acts continuously on the stability space $\mathrm{Stab}(T)$, which is a complex manifold. It's a fairly open line of inquiry to try to use the action on $\mathrm{Stab}(T)$ to prove theorems about the group G.

The goal of this talk will be to explain what all of this looks like in the simplest non-trivial example, where the triangulated category is the $2CY$ category of type A_2, and the group G is the 3strand Artin braid group. The study of stability conditions in this example will both recover some old - and discover some new! - mathematics surrounding $SL_2(Z)$ and its action on the hyperbolic plane. (The new mathematics is all joint work with subsets of Asilata Bapat, Louis Becker, and Anand Deopurkar.)

20.8. Arithmetic geometry of representation varieties with regular monodromy
Speaker: GyeongHyeon Nam (The University of Queensland)
Time: 14:00 Wed 8 December
Place(s):
Author(s): GyeongHyeon Nam

Representation varieties, character varieties and character stacks play a central role in diverse areas of Mathematics, including non-abelian Hodge theory, Geometric Langlands and mathematical physics. Their topology and geometry are extremely rich and the subject of active research for several decades.

The aim of this talk is to count points over finite fields of parabolic representation varieties with regular semisimple, regular unipotent and arbitrary unipotent conjugacy classes at the punctures. One of the new features in our counting formulas is the appearance of the order of parabolic Springer fibres. As a corollary of the counting formulas, we obtain an expression for the E-polynomial of the representation variety. This is joint work with Anna Puskas and Masoud Kamgarpour.

20.9. A Kazhdan–Lusztig correspondence for a vertex algebra associated to $\mathfrak{sl}_3$

Speaker: David Ridout (The University of Melbourne)
Time: 09:00 Wed 8 December
Place(s):
Author(s): David Ridout

The original Kazhdan–Lusztig correspondence describes an equivalence between certain module categories of a quantum group and an affine algebra. The latter can be lifted to a module category for an affine vertex operator algebra and this had led to many "generalised Kazhdan–Lusztig correspondences" relating quantum group modules to vertex operator algebra modules.

Here, I will outline a conjectural, but still very interesting, example of a such a correspondence between an unrolled restricted quantum group and an admissible-level affine vertex operator algebra, both related to $\mathfrak{sl}_3$. No prior understanding of these adjectives will be assumed and the talk will concentrate on the representation theory of the quantum group.

20.10. K-Theoretic Schubert Calculus and Stochastic Processes

Speaker: Travis Scrimshaw (Osaka City University)
Time: 16:00 Tue 7 December
Place(s):
Author(s): Travis Scrimshaw

The (connective) K-theory ring of the Grassmannian, the set of k dimensional planes in n dimensional complex space, can be described using certain symmetric functions called symmetric Grothendieck functions with a single parameter. The dual basis (under the natural inner product where Schur functions are an orthonormal basis) with refined parameters was shown to be given as a combinatorial sum over reverse plane partitions by Galashin, Grinberg, and Liu in 2016. In this talk, we show that these refined dual Grothendieck functions describe the transition probabilities (up to an overall constant) of a particle process given by Dieker and Warren in 2008, where the particles move according to the geometric distribution and can push smaller particles. We relate them by using the branching rule for refined dual Grothendieck polynomials. We also give a bijection between the last passage percolation data from (random) matrices with geometric weights by using the Schur expansion of refined dual Grothendieck functions, which can equivalently be described using RSK or a crystal structure on reverse plane partitions. This is based on joint work with Kohei Motegi (arXiv: 2012.15011).

20.11. Monoidal categories and cryptography

Speaker: Daniel Tubbenhauer (The University of Sydney)
Time: 14:30 Tue 7 December
Place(s):
Author(s): Daniel Tubbenhauer

If you do not know what the two notions in the title have in common, then this is your talk.

This is a friendly introduction explaining monoidal categories can be used to create representation theoretical approaches to cryptography that resists linear attacks.

Based on joint work in progress with M. Khovanov and M. Sitaraman.

20.12. Mackey functors as G-commutative monoids

Speaker: Ivo De Los Santos Vekemans (Australian National University)
Time: 17:30 Tue 7 December
Place(s):
Author(s): Ivo De Los Santos Vekemans

Given a finite group G, G-coefficient systems, G-Mackey functors and G-Tambara functors arise in the context of G-actions, encoding operations which behave like induction, restriction, conjugation, and tensor induction. For example in equivariant homotopy theory Mackey and Tambara functors replace abelian groups and commutative rings respectively. In this talk we see how Mackey functors are the coherent G-commutative monoids in the G-symmetric monoidal category of coefficient systems, defining these terms as we go. We will also see a similar statement relating Tambara functors and Mackey functors.

21. Topology

21.1. Gordian unlinks

Speaker: José Ayala Hoffmann (The University of Melbourne)
Time: 14:30 Thu 9 December
Place(s):
Author(s): José Ayala Hoffmann

Thick knots are smooth embedded loops in 3-space that satisfy a bound on curvature and have positive thickness. We prove that spaces consisting on a finite number of thick unlinked unknots have connected components different from the one consisting of disjoint round circles.

21.2. Expansive rigid motions and a piecewise-linear sphere

Speaker: Asilata Bapat (Australian National University)
Time: 16:00 Wed 8 December
Place(s):
Author(s): Asilata Bapat, Anand Deopurkar, and Anthony Licata

Consider a configuration of marked points in the plane and straight rods connecting pairs of points. A planar motion of the points is called expansive if it preserves the lengths of the rods and weakly increases the distance between any two marked points. Minimal rod configurations with no non-trivial expansive motions are called "pointed pseudo-triangulations". They enjoy a number of fascinating properties, studied extensively in the theory of rigid motions over the last twenty years. In particular, the pointed pseudo-triangulations of a point configuration generate a natural simplicial complex, which is topologically a closed ball.

This talk has two aims. First, we discuss a piecewise-linear structure on the boundary of the closed ball described above, and how it deforms as we vary the point configuration. Second, we view this framework through an unexpected new lens: namely, decomposing objects in a certain triangulated category.

21.3. Diagrams of Legendrian Knots In Closed Contact Manifolds

Speaker: Jack Brand (Australian Mathematical Sciences Institute)
Time: 08:30 Wed 8 December
Place(s):
Author(s): Jack Brand

The study of a projection of a knot in a 3-manifold to some two dimensional submanifold is an extremely useful way to study the knot itself. In the context of contact geometry, there are preferred projections of knots called the 'front projection' and the 'Lagrangian projection', and are useful in their own different ways. For example, Legendrian diagrams are useful for computing the classical Legendrian knot invariants (Thurston-Bennequin number and rotation number) and Lagrangian diagrams are particularly useful for computing the Legendrian contact homology of a Legendrian knot. These projections are well understood in $\mathbb{R}^3$ with its standard contact structure and only a small handful of other contact 3-manifolds, such as contact circle bundles. In this talk, we show how we can find projections of knots in any closed contact manifold using its open book decomposition.

21.4. Surface knots and bisections of the 4-sphere

Speaker: Diarmuid Crowley (The University of Melbourne)
Time: 14:00 Thu 9 December
Place(s):
Author(s): Diarmuid Crowley

Unknotting for topological knots of orientable surfaces states that if the fundamental group of the complement is infinite cyclic, then the knot is standard.

Surgery theoretic proofs of unknotting rely on first showing that λ_F, the equivariant intersection form of the infinite cyclic cover of the complement, is standard. Recently Conway and Powell proved unknotting for surfaces of genus at least 3, using algebraic stability results to control λ_F.

In this talk I report on a joint with Jim Davis where we give a geometric proof that λ_F is standard for any genus. As a consequence we deduce that topological unknotting holds for any genus. The proof relies on showing that every knot lies within a "trivial bisection" of the 4-sphere by Seifert 3-manifolds.

21.5. Welded tangles and the Kashiwara-Vergne groups

Speaker: Zsuzsanna Dancso (The University of Sydney)

Time: 14:30 Wed 8 December

Place(s):

Author(s): Zsuzsanna Dancso, Iva Halacheva, Marcy Robertson

This talk explores an intricate relationship between four-dimensional knot theory and Lie theory. Welded tangles are a class of tubes with singular vertices, embedded in R^4. The Kashiwara-Vergne groups are symmetry groups of a set of equations in Lie theory, called the Kashiwara-Vergne equations. We identify the Kashiwara-Vergne groups as automorphisms of (completed) welded foams and their "associated graded" diagrammatic space, arrow diagrams. (Joint work with Iva Halacheva and Marcy Robertson, building on joint work with Dror Bar-Natan.)

21.6. Hyperbolic knots given by positive braids with at least two full twists

Speaker: Thiago de Paiva Souza (Monash University)

Time: 14:00 Wed 8 December

Place(s):

Author(s): Thiago de Paiva Souza

Thurston proved that any non-trivial knot in the 3-sphere is either a torus knot, a satellite knot, or has hyperbolic complement. It is helpful to know the geometric type of the knot when we are studying it because we will know the right tools to use. For example, If the knot is hyperbolic, then various additional invariants coming from hyperbolic geometry become available, e.g. volume, systole, cusp shapes. Thus, the geometric classification of knots has been an important task in modern research in knot theory.

Alexander's theorem tells us that every knot can be represented as the closure of a braid . So, a lot of study has been done to understand the knot types of knots given by braids. But, there haven't been many concrete conditions on braids to ensure their geometric type. For example, not much is known about the geometric classification of T-knots, which a family of knots arising from dynamics.

In this talk, we give some conditions on positive braids with at least two full twists that ensure their closure is a hyperbolic knot, with applications to the geometric classification of T-links and twisted torus knots.

21.7. TBA

Speaker: Sophie Ham (Monash University)

Time: 08:00 Thu 9 December

Place(s):

Author(s): Sophie Ham

TBA

21.8. Greedy retriangulation of 3-manifolds

Speaker: Alexander He (The University of Queensland)

Time: 14:30 Tue 7 December

Place(s):

Author(s): Alexander He

Computation with 3-manifolds depends not only on the topology of the manifold, but also on the properties of the chosen triangulation of that manifold. For instance, many algorithms have running times that are exponential in the number of tetrahedra in the input triangulation, which means that it is often useful (indeed, sometimes crucial) to first retriangulate with as few tetrahedra as possible. In this talk, we discuss greedy methods for retriangulation, with a focus on two new applications.

First, we describe how we used retriangulation to construct a counterexample to an interesting but unpublished conjecture of Jaco and Rubinstein. Second, we outline some work in progress towards developing an effective method for minimising an important measure of the complexity of a triangulation known as the treewidth.

This is joint work with Ben Burton.

21.9. Conormal Spaces and Whitney Stratifications

Speaker: Martin Helmer (Australian National University)

Time: 15:00 Thu 9 December

Place(s):

Author(s): Martin Helmer and Vidit Nanda

We describe a new algorithm for computing Whitney stratifications of complex projective varieties. The main ingredients are (a) an algebraic criterion, due to Lê and Teissier, which reformulates Whitney regularity in terms of conormal spaces and maps, and (b) a new interpretation of this conormal criterion via ideal saturations, which can be practically implemented on a computer. We show that this algorithm improves upon the existing state of the art by several orders of magnitude, even for relatively small input varieties.

21.10. Symmetries of 3D and 4D expansions

Speaker: Tamara Hogan (The University of Melbourne)

Time: 15:00 Wed 8 December

Place(s):

Author(s): Zsuzsanna Dancso, Tamara Hogan and Marcy Robertson

Drinfel'd associators are well-studied objects from quantum algebra which result from a weakening of the co-associativity condition in a Hopf algebra. Kashiwara-Vergne solutions give a pair of convergent power series which can be used to re-express the Baker-Campbell-Hausdorff formula. Both of these sets of objects form bi-torsors with left (respectively right) symmetry groups given by GT_1 (GRT_1) and KV (KRV). A key result of Alekseev and Torossian in 2012 showed that there is an injective bi-torsor map from Drinfel'd associators to Kashiwara-Vergne solutions. Results from Bar-Natan and Bar-Natan-Dancso gave a topological perspective on this by showing that these sets of objects can be given by homomorphic expansions of algebras of 3D and 4D knotted objects respectively. However, a full translation of the bi-torsor map of Alekseev-Torossian to this topological language has not been completed, with the two symmetry group maps yet to be constructed. In this talk, I will explain the results of a forthcoming paper from myself, Dancso and Robertson in which we complete part of the translation of Alekseev-Torossian's bi-torsor map to the topological interpretation. We do this by giving a arrow-diagrammatic interpretation of the right-symmetry group map $\rho : \mathsf{GRT}_1 \to \mathsf{KRV}$.

21.11. A symplectic basis for 3-manifold triangulations

Speaker: Daniel Mathews (Monash University)

Time: 16:30 Wed 8 December

Place(s):

Author(s): Daniel Mathews

Walter Neumann and Don Zagier in the 1980s introduced a symplectic vector space associated to an ideal triangulation of a cusped 3-manifold. We will discuss an interpretation for this symplectic structure in terms of the topology of the 3-manifold. This work, joint with Jessica Purcell, involves train tracks, Heegaard splittings, and is related to Ptolemy varieties, geometric quantisation, and the A-polynomial.

21.12. Fully simple maps and topological recursion

Speaker: Ellena Moskovsky (Monash University)

Time: 08:00 Wed 8 December

Place(s):

Author(s): Ellena Moskovsky

An ordinary map is an embedding of a graph on a surface such that the complement of the graph is a disjoint union of disks. The enumeration of ordinary maps is one of the prototypical examples of a combinatorial enumeration satisfying a particular recursion called topological recursion (TR). On the other hand, a fully simple map is a certain type of ordinary map where we add a constraint on face incidences. It has been conjectured that ordinary maps and fully simple maps are related via a certain symplectic transformation of the TR input data, implying that fully simple maps also satisfy TR. In this talk, we will discuss this relation between ordinary and fully simple maps, as well as recent joint work-in-progress with Norman Do towards a proof of the conjecture that fully simple maps too are governed by TR.

21.13. A counterexample to vanishing conjectures in negative K-theory

Speaker: Amnon Neeman (Australian National University)

Time: 16:00 Tue 7 December

Place(s):

Author(s): Amnon Neeman

Schlichting conjectured that the negative algebraic K-theory of all abelian categories must vanish, and Antieau, Gepner and Heller strengthened the conjecture, speculating that the negative K-theory of all stable infinity-categories with bounded t-structures must vanish.

The conjectures turn out to be false. We'll discuss the counterexample, as well as a recent idea that might lead to progress on yet another outstanding conjecture.

21.14. Normal surfaces and the complexity of 3-manifolds

Speaker: Jonathan Spreer (The University of Sydney)

Time: 09:00 Thu 9 December

Place(s):

Author(s): Jonathan Spreer

The complexity c(M) of a 3-manifold M is defined to be the smallest number of tetrahedra required to triangulate M.

In this talk I will go over the basic ideas behind using normal surface theory and, more broadly, the theory of surfaces embedded in 3-dimensional manifolds, to determine tight lower bounds on the complexity of these manifolds.

I will then present triangulations of an infinite family of once-cusped hyperbolic 3-manifolds realising their complexity.

This is joint work with Hyam Rubinstein and Stephan Tillmann.

21.15. Twisting, ladder graphs and A-polynomials

Speaker: Emily Thompson (Monash University)

Time: 15:00 Tue 7 December

Place(s):

Author(s): Emily Thompson

The A-polynomial is a powerful knot invariant that captures information about the geometry and topology of a knot complement, however, it remains difficult to compute in general. In this talk we will consider families of knots related by twisting, showing that the calculation of their A-polynomials can be simplified significantly, particularly for large numbers of twists. This result is inspired by connections to cluster algebras and the proof relies on the combinatorics of ladder graphs.

21.16. Where do quantum invariants come from?

Speaker: Roland van der Veen (University of Groningen)

Time: 09:00 Wed 8 December

Place(s):

Author(s): Roland van der Veen

The aim of this talk is to give a non-technical and knot theoretically motivated construction of quantum groups and the quantum knot invariants that they give rise to. The key notion is that of an OU tangle diagram. This is a diagram in which every strand first passes over and then under. We will explain how any braid diagram can be isotoped to a unique minimal OU diagram. Writing this procedure in an algebraic context comes down to the Drinfeld double construction that is at the root of most quantum invariants.

This is joint work with Dror Bar-Natan and Zsuzsanna Dancso

22. Visualisation and Mathematical Art

22.1. Functional origami lampshades

Speaker: Michael Assis (The University of Melbourne)
Time: 08:30 Wed 8 December
Place(s):
Author(s): Michael Assis

There are various techniques for creating origami lampshades. We will present a technique where a given silhouette is formed through folding appropriate creases and repeated $n \geq 3$ times symmetrically around an axis, popularized by Jun Mitani through his software Ori-Revo. The folded silhouettes do not need to be limited to line segments but can be continuous curves. We will use as our silhouettes mathematical functions generated from curved creases to create "functional" origami lampshades.

22.2. Visualisations of a generalised Newton method

Speaker: Bethany Caldwell (University of South Australia)
Time: 09:00 Wed 8 December
Place(s):
Author(s): Professor Regina Burachik, Miss Bethany Caldwell, Associate Professor Yalçın Kaya

Graphical visualisation of numerical methods can yield a range of colourful images which convey useful interpretations as well as constitute works of art. This research proposes a family of new variants of the Newton method with the potential advantage of having a larger convergence region. The new family is quadratically convergent just like the classical Newton method. To demonstrate the merits of this method over the classical Newton approach we colour-code regions of the plane according to the convergence properties. We do this for problems in two dimensions as well as univariate problems over the complex plane.

22.3. That's not a proof, it's a picture!

Speaker: James East (Western Sydney University)
Time: 15:00 Fri 10 December
Place(s):
Author(s): James East

Un-named Mathematician 1: That's not a proof, it's a picture!

Un-named Mathematician 2 (pointing to equations): These are all pictures!

Somehow mathematics appeals to me the most when it's visual. Sometimes the mathematical objects themselves are inherently diagrammatic, or sometimes there is a key picture that makes sense of everything: both, if you're lucky. Almost all of my favourite projects have involved a picture/artwork, from which the abstract mathematical details dangle like Christmas ornaments. I'll give a few examples in this talk.

22.4. Visual design of an outreach workshop based on bijections

Speaker: Sean Gardiner (UNSW Sydney)
Time: 08:00 Fri 10 December
Place(s):
Author(s): Jason Atnip, Yudhistira A. Bunjamin, Sean Gardiner

In June 2021, the School of Mathematics and Statistics at UNSW Sydney held its annual Girls Do The Maths event, featuring bespoke interactive workshops for the first time. The purpose of these workshops is to promote independent mathematical thinking, as opposed to simply presenting a particular feature or application of mathematics.

One of the workshops, titled 'Counting Conundrums', was designed to introduce students to the concept of bijection by comparing four interactive visual enumeration tasks. In this talk we will discuss the design process of this workshop, focusing on the choices made regarding the selection of the counting tasks and their visual presentation, which were informed by the goals of fostering student engagement while both disguising the connections between the tasks and quietly encouraging the discovery of thinking bijectively.

The talk "Designing mathematics outreach workshops for operational versatility" by Yudhistira Bunjamin in the Equity, Diversity and Inclusivity in Mathematics special session will address the logistics of this workshop along with others presented at the 2021 Girls Do The Maths event.

22.5. Creating Non-Digital Maths Art: decisions, discipline and dizzying possibilities

Speaker: Karen Amanda Harris (University of the Arts London)

Time: 08:00 Wed 8 December
Place(s):
Author(s): Karen Amanda Harris

In 2D mathematical art, non-digital tools can reveal a dizzying world of possibilities. Yet their potential is often overlooked and underestimated.

Roaming through these possibilities, with ruler and compasses at the core, presents us with an imaginative and intellectual challenge. At every stage, the geometry offers choices: it is up to us to make our selection. Which points do we connect to which; where do our lines end; where do they change direction? At what angle?

And what surprises might emerge? What fantasy-inspired images might be created? What illusion of depth, sense of movement and hinting of narrative might be evoked?

A vital aspect of non-digital art is that it forces us to commit to the decisions we make – or at least to consider the consequences very carefully before pen touches paper. These materials do not allow for unlimited changes. Yet this very discipline, this restraint, can be paradoxically liberating.

In this talk, I will explore my own adventures with line, colour and paper to form the mysterious and unpredictable.

22.6. Encoding language in mosaic knitting

Speaker: Jo-ann Larkins (Federation University Australia)

Time: 14:30 Fri 10 December
Place(s):
Author(s): Jo-ann Larkins

Knitting is a form of binary coding, consisting of just two basic stitches, knit and purl, each creating visibly different fabric. The ability of knitting to carry coded messages has been exploited in wartime as a form of steganography, where the coded message is concealed from casual scrutiny within the structure and patterning of the knitted object. Such coding aims to create secret messages, undetectable to all but their intended recipients. Hitomezashi stitching, a type of Japanese embroidery consisting of interlocking evenly spaced running stitches, has also been used to encode binary digits on two dimensional grids with the stitch representing binary one and the space binary zero. The interlocking patterns formed by encoding stiches from two perpendicular axes provide boundaries for intricate two-colour mathematical patterns. Text is encoded for binary computing languages using ASCII and with an extended symbol set in Unicode-8. Binary representations of ASCII have been used to create hitomezashi inspired mathematical art encoding text. These hitomezashi colourings bear a striking resemblance to the traditional charts created by Barbara Walker in the 1960s for mosaic knitting patterns. Mosaic knitting is a type of two-colour slipped stitch colourwork usually worked in high contrast colours. This paper explores the affordability and constraints of mosaic knitting charting to encode ASCII and Unicode representation of language. Aspects explored and illustrated in knitted swatches include allowable axes of symmetry and stepwise constraints of possible stitch and row colourings.

22.7. The geometry of rectangles in ancient Mesopotamia

Speaker: Daniel Francis Mansfield (University of New South Wales)

Time: 13:00 Fri 10 December
Place(s):
Author(s): Daniel Francis Mansfield

Mathematics is said to have begun long ago in ancient Mesopotamia, also known as the cradle of civilization. This culture had slipped into legend until the late 19th century when archaeologists uncovered thousands upon thousands of clay documents from lost cities such as Sippar, Lasa, and Babylon. Amongst these were mathematical and geometric texts, many are yet to be translated and some are surprisingly advanced. This talk introduces new discoveries regarding their understanding and applications of geometry.

22.8. Connecting sewing to higher mathematics

Speaker: Asha Rao (Royal Melbourne Institute of Technology)
Time: 08:30 Fri 10 December
Place(s):
Author(s): Asha Rao

Sewing is the art of converting a piece of fabric (a 2D object) into a 3-D garment that fits a human body. Mathematics is an essential part of this conversion – ratios, fitting to curves etc. all have their place. In the talk I will talk of some generalities and then relate the process of starting from higher mathematics and producing a garment that could be consider high fashion.

22.9. Stitching the wallpaper groups

Speaker: Katherine Seaton (La Trobe University)
Time: 14:00 Fri 10 December
Place(s):
Author(s): Katherine Seaton

Mathematical fibre artists delight in a form they term *complete symmetry samplers*. That is, all possible symmetry groups consistent with the inherent constraints of the fibre art employed (e.g. knitting, cross-stitch) are depicted within the one sampler. In this talk, I will describe the traditional Japanese embroidery form hitomezashi and show that it is possible to depict twelve of the seventeen wallpaper groups using it.

22.10. Discussion of Mathematical Art at future AustMS meetings

Speaker: Katherine Seaton (La Trobe University)
Time: 16:00 Fri 10 December
Place(s):
Author(s): Katherine Seaton

In this timeslot, we will hold a discussion of the possibilities for Mathematical Art at AustMS meetings. Exhibitions and talks on these topics are part of the JMM in the US, and there is a dedicated Bridges conference generally held in the Northern Hemisphere. What level of enthusiasm is there for future exhibitions, workshops or talks here at AustMS?

Index of Speakers