Conference Timetable Summary

	Monday	Tuesday	Wednesday	Thursday	Friday
8:00					
8:30		Registration South 1			
9:00		Opening Ceremony Lectures by Prize Winners *South 1*	Plenary talk *Joshi*	Plenary talk *Ulcigrai*	Plenary talk *Giga*
9:30					
10:00			Coffee Break	Coffee Break	Coffee Break
10:30		Coffee Break	Plenary talk *an Huef*	Plenary talk *Steinberg*	Plenary talk *Norbury*
11:00		Plenary talk *Krieger* South 1			
11:30			*Debate*	Plenary talk *Trudgian*	Plenary talk *Samotij*
12:00		Lunch			
12:30			Lunch	Lunch	Lunch
13:00					
13:30		Plenary talk *Sikora*	Special Sessions	Special Sessions	Special Sessions
14:00		Education Afternoon / Special Sessions			
14:30		Coffee Break		Coffee Break	Coffee Break
15:00		Education Afternoon / Special Sessions	Coffee Break	Plenary talk *Rylands*	Special Sessions
15:30			Special Sessions		
16:00				AustMS AGM	
16:30					
17:00					
17:30					
18:00	WIMSIG Dinner *Campus Centre*	Welcome Reception *Cinque Lire Cafe*			
18:30				Conference Dinner *MCG*	
19:00					
19:30					
20:00					

Contents

Foreword

Welcome to Monash University's Clayton Campus for the 63rd Annual Meeting of the Australian Mathematical Society. It is very exciting to see so many academics and graduate students coming together from around Australia and 26 other countries to exchange ideas and to celebrate mathematics.
This year we have a few innovations, including plenary lectures focussing on education and on equity and diversity. We also, for the first time, have a special session on Inclusivity, diversity, and equity in mathematics. Another innovation this year is bush dancing at the conference dinner on Thursday night – make sure you wear your dancing shoes!
An event of this scale does not happen without a lot of people pitching in. I would particularly like to thank all the people listed below for all their assistance in making this event happen.
Finally, I wish you a productive and enjoyable week at Monash,

Prof Ian Wanless

Conference Director

Program Committee

Ben Burton (UQ)
Alan Carey (ANU)
Michael Coons (Newcastle)
Alice Devillers (UWA)
Vlad Ejov (Flinders)
Roozbeh Hazrat (WSU)
Birgit Loch (Latrobe)
Giang Nguyen (Adelaide)
Milena Radnovic (Sydney)
Vera Roshchina (UNSW)
Ian Wanless (Monash)
Valentina Wheeler (Wollongong)

Local Organising Committee

Julie Clutterbuck – Special sessions
Gregoire Loeper – Treasurer
Angelika Nikolov-Arvela – Secretary
Jessica Purcell – WIMSIG dinner
Daniel Mathews – Childcare
Daniel Horsley – Debate
Mark Flegg – This document
Deborah Jackson – Nametags
John Chan, Jerome Droniou, Jeremy Hague – Website
John Banks – Registration system
Gertrude Nayak
Anna Haley
Greg Markowsky

Conference Sponsors

MONASH University

ACEMS

AUSTRALIAN RESEARCH COUNCIL CENTRE OF EXCELLENCE FOR
MATHEMATICAL AND STATISTICAL FRONTIERS

Special thanks also to Prof Kate Smith-Miles through the Georgina Sweet Award component of her ARC Australian Laureate Fellowship, for sponsoring the Women in Mathematics dinner.

Conference Program

Overview of the Academic Program

There are 305 talks, including 11 plenary lectures and 20 special sessions. The Education Afternoon on Tuesday comprises talks of interest to all mathematical educators.

Plenary Lecturers

Yoshikazu Giga (University of Tokyo)
Astrid an Huef (Victoria University of Wellington) – Hanna Neumann Lecturer
Nalini Joshi (University of Sydney) – ANZIAM Lecturer
Holly Krieger (Cambridge) – Mahler Lecturer
Paul Norbury (University of Melbourne)
Leanne Rylands (Western Sydney University)
Wojciech Samotij (Tel Aviv University) – ECR Lecturer
Joanna Sikora (ANU)
Benjamin Steinberg (City University of New York)
Tim Trudgian (UNSW Canberra)
Corinna Ulcigrai (University of Zurich)
▷ Timetable of Plenary Lectures – page 8

Special Sessions

Education Afternoon (Tues in G03)

2:20pm Julia Collins and Katherine Seaton: Knitting and Folding Mathematics

Mathematical thinking is not confined to mathematicians, but one place you may not expect to find it is in the world of crafts. Even the most maths-anxious knitters will display an astonishing familiarity with concepts from geometry, topology, number theory and coding, while modern origami artists are turning to mathematical algorithms to create models previously thought to be unfoldable. This talk will highlight a number of surprising connections between maths and craft, and will be followed by a hands-on session facilitated by Maths Craft Australia where people can create some mathematical craft for themselves. (Knitting/crochet needles and origami paper will be provided, but participants are also encouraged to bring their own! Knitting in the audience is strictly encouraged.)

3:10pm Marty Ross: How I teach, why the Mathologer is evil, and other indiscrete thoughts

In this shamelessly narcissistic talk I will reveal the One True Secret to teaching mathematics. Along the way I will explain why you can and should ignore STEM, calculators, Mathematica, iPads, the evil Mathologer, constructivism, growth mindset, SOLO, Bloom, flipping classrooms, centering children, lesson plans, skeleton notes, professional standards and professional development and many other modern absurdities.

3:35pm David Treeby: How to Instil Mathematical Culture in Secondary Education

Over the past few decades, mathematicians have ceded the educational space to two groups: mathematics educators and technology companies. This has had a dire effect on what mathematics is taught and how it is taught. The result is a commodified brand of distorted mathematics. This talk will focus on how some well-resourced schools have resisted these changes, and how broad and equitable change will require the support of working mathematicians and their professional bodies.

4pm Burkard Polster – Mathologer: explaining tricky maths on YouTube

In this session I'll talk about my experience running the YouTube channel Mathologer and I'll give you a sneak peek of the video that I am currently working on.

Social Program

- 6:15pm for 6:45pm Mon
  WIMSIG Dinner
  Campus Centre
- 6pm Tues
  Welcome reception
  Cinque Lire Cafe
- 6:30pm Thurs
  Conference Banquet
  Olympic Room, Melbourne Cricket Ground (MCG)

Annual General Meeting of the Society

- 4pm Thurs
  AustMS AGM
  Lecture Theatre G81 (Same venue as most plenaries)

Conference Information Desk

The registration/information desk will be located outside the venue for the plenary talks (South 1 on Tue Morning, and G81 for the rest of the week). This desk will be staffed before the opening ceremony and each day during morning tea. If you have any issues you can also email austms2019@monash.edu

Plenary Lectures in South 1 [Krieger] or G81 [Others]

▷ Tue 3 December 2019

11:00 ► Holly Krieger (University of Cambridge)
Unlikely intersections in arithmetic and dynamics

13:30 ► Joanna Sikora (Australian National University)
Advancing women in Australian Mathematics: context, challenges and achievements

▷ Wed 4 December 2019

09:00 ► Nalini Joshi (The University of Sydney)
When applied mathematics collided with algebra

10:30 ► Astrid an Huef (Victoria University of Wellington)
Algebraic systems of isometries

▷ Thu 5 December 2019

09:00 ► Corinna Ulcigrai (University of Zurich)
Shearing and mixing in surface flows

10:30 ► Benjamin Steinberg (City University of New York)
Monoids in Representation Theory, Markov Chains, Combinatorics and Operator Algebras

11:30 ► Timothy Trudgian (UNSW Canberra)
Primes = Hard +O(1)

15:10 ► Leanne Rylands (Western Sydney University)
The mathematics problem

▷ Fri 6 December 2019

09:00 ► Yoshikazu Giga (University of Tokyo)
On total variation flow type equations

10:30 ► Paul Norbury (The University of Melbourne)
Enumerative geometry via the moduli space of super Riemann surfaces.

11:30 ► Wojciech Samotij (Tel Aviv University)
Large deviations in random graphs

Special Session 1: Algebra

Organisers Heiko Dietrich, Anne Thomas

Contributed Talks

▷ Wed 4 December 2019

13:30 Jeroen Schillewaert (University of Auckland)
On exceptional Lie geometries (p. 68)

13:55 Subhrajyoti Saha (Monash University)
Skeleton groups and their isomorphism problem (p. 67)

14:20 Primoz Moravec (University of Ljubljana)
Gaps in probabilities of satisfying some commutator identities (p. 66)

14:45 Michal Ferov (The University of Newcastle)
Separating conjugacy classes in wreath products of groups (p. 65)

15:35 Marcos Origlia (Monash University)
Simply transitive NIL-affine actions of solvable Lie groups (p. 67)

16:00 Santiago Barrera Acevedo (Monash University)
Cocyclic Hadamard matrices of order 4p (p. 65)

16:25 James Mathew Koussas (La Trobe University)
Varieties of semiassociative relation algebras (p. 66)

16:50 Lauren Thornton (University of the Sunshine Coast)
On properties of descending chains (p. 68)

17:15 Alejandra Garrido (The University of Newcastle)
Locally compact topological full groups are locally finite (p. 65)

17:40 Colin David Reid (The University of Newcastle)
Locally compact piecewise full groups of homeomorphisms of the Cantor set (p. 67)

▷ Thu 5 December 2019

13:30 Amnon Neeman (Australian National University)
Non Fourier-Mukai functors (p. 67)

13:55 Robert McDougall (University of the Sunshine Coast)
Interpreting a radical theory identity for classes of associative rings (p. 66)

14:20 Abdullahi Umar (Khalifa University of Science, Technology)
Some Remarks on monoids of contraction mappings of a finite chain (p. 68)

▷ Fri 6 December 2019

13:30 James East (Western Sydney University)
Presentations for diagram algebras and categories (p. 65)

13:55 Richard Garner (Macquarie University)
Generalising the étale groupoid–complete pseudogroup correspondence (p. 65)

14:20 Tim Stokes (University of Waikato)
Demonic composition and inverse semigroups. (p. 68)

15:10 Tomasz Kowalski (La Trobe University)
A little beyond wreath and block (p. 66)

15:35 Thomas Quella (The University of Melbourne)
Takiff superalgebras and conformal field theory (p. 67)

16:00 Marcel Jackson (La Trobe University)
Algebras defined by equations (p. 66)

Special Session 2: Applied and Industrial Mathematics

Organisers Christian Thomas, Lele (Joyce) Zhang

Keynote Talks

▷ Tue 3 December 2019

15:10 Terry O'Kane (CSIRO)
Simple Markovian closures for inhomogeneous turbulence (p. 69)

Contributed Talks

▷ Tue 3 December 2019

14:20 Dylan Harries (CSIRO)
Applications of temporally regularised matrix factorisations to the analysis of climate data (p. 69)

16:00 Samithree Rajapaksha (Monash University)
Approximating Link Travel Time Distributions (p. 70)

16:25 Vassili Kitsios (CSIRO)
Ensemble transform Kalman filter estimation of thermodynamic parameters in a coupled general circulation model (p. 69)

16:50 Sevvandi Priyanvada Kandanaarachchi (Monash University)
DOBIN: dimension reduction for outlier detection (p. 69)

17:15 Lele (Joyce) Zhang (The University of Melbourne)
Courier route optimization with unloading bays information and reservation systems (p. 70)

Special Session 3: Category Theory

Organisers David Roberts, Marcy Robertson

Keynote Talks

▷ Wed 4 December 2019

13:30 Richard Garner (Macquarie University)
The free tangent category on an affine connection (p. 71)

Contributed Talks

▷ Wed 4 December 2019

14:20 Michelle Strumila (The University of Melbourne)
Graphical Sets and Mapping Class Groups (p. 72)

14:45 Giacomo Tendas (Macquarie University)
Regular Theories Enriched Over Finitary Varieties (p. 72)

15:35 Martina Rovelli (The Australian National University)
An embedding of the homotopy theory of 2-categories into that of 2-complicial sets (p. 71)

16:00 Bryce Clarke (Macquarie University)
Characterising split opfibrations using lenses (p. 71)

16:25 Bregje Pauwels (The University of Sydney)
t-structures and approximable triangulated categories (p. 71)

16:50 David Roberts (The University of Adelaide)
Localising by spans and cospans, and functoriality of associated algebras (p. 71)

Special Session 4: Combinatorics and Graph Theory

Organisers Joanne Hall, David Wood

Keynote Talks

▷ Tue 3 December 2019

15:10 Andrii Arman (Monash University)
Generation of random graphs with given degrees (p. 73)

Contributed Talks

▷ Tue 3 December 2019

14:20 Benjamin Jones (Monash University)
Excluded minors for classes of binary functions (p. 76)

16:00 Rui Zhang (Monash University)
Bounded Difference Inequalities for Graph-Dependent Random Variables (p. 78)

16:25 Matthias Fresacher (University of Adelaide)
Learning Large Random Graphs Via Group Queries (p. 75)

16:50 Angus Southwell (Monash University)
Counting automorphisms of random trees with martingales (p. 77)

17:15 Richard Brak (The University of Melbourne)
Universal Bijections for Positive Algebraic Structures (p. 73)

17:40 Kevin Limanta (University of New South Wales)
A curious bijection between Dyck paths (p. 76)

▷ Wed 4 December 2019

13:30 Nicholas Cavenagh (University of Waikato)
Heffter Arrays with compatible and simple orderings (p. 73)

13:55 Ajani De Vas Gunasekara (Monash University)
On determining when small embeddings of partial Steiner triple systems exist (p. 74)

14:20 Adam Gowty (Monash University)
New bounds on the maximum size of Sperner partition systems (p. 75)

14:45 Daniel Horsley (Monash University)
Generating digraphs with derangements (p. 76)

15:35 Guillermo Pineda-Villavicencio (Deakin University)
Minkowski decompositions of polytopes via geometric graphs (p. 77)

16:00 Michael Payne (La Trobe University)
Geometric hypergraph colouring problems (p. 77)

16:25 Adam Mammoliti (Monash University)
On the Cyclic Matching sequenceablility of regular graphs (p. 76)

16:50 Michael James Gill (Monash University)
Perfect 1-factorisations of K_{16} (p. 75)

17:15 William Crawford (Monash University)
Properties of the polytope of polystochastic matrices (p. 74)

17:40 Graham Farr (Monash University)
Some problems suggested by the Online Graph Atlas project (p. 74)

▷ Thu 5 December 2019

13:30 Amin Sakzad (Monash University)
Middle Product Learning With Errors (p. 77)

13:55 Lynn Batten (Deakin University)
How generic ring algorithms and labelled binary trees helped solve an outstanding factoring problem in number theory. (p. 73)

14:20 Andrea Burgess (University of New Brunswick)
The firebreak problem (p. 73)

▷ Fri 6 December 2019

13:30 Sanming Zhou (The University of Melbourne)
The vertex-isoperimetric number of the incidence graphs of unitals and finite projective spaces (p. 78)

13:55 Greg Markowsky (Monash University)
The Cheeger constant for distance-regular graphs. (p. 77)

14:20 Binzhou Xia (The University of Melbourne)
Some examples of nonnormal Cayley graphs on nonabelian simple groups (p. 78)

15:10 Joanne Hall (Royal Melbourne Institute of Technology)
Constructions of Difference Covering Arrays using Skolem sequences (p. 75)

15:35 Vesa Kaarnioja (University of New South Wales)
An improved lower bound on Hong and Loewy's numbers (p. 76)

16:00 Son Hoang Dau (RMIT University)
MaxMinSum Steiner Systems for Access-Balancing in Distributed Storage (p. 74)

16:25 Kevin Hendrey (Institute for Basic Science)
Covering radius in the Hamming permutation space (p. 75)

Special Session 5: Computational Mathematics

Organisers Bishnu Lamichhane, Quoc Thong Le Gia

Keynote Talks

▷ Wed 4 December 2019

13:55 Gianmarco Manzini (Consiglio Nazionale delle Ricerche (CNR) - Italy)
The Virtual Element Method for solving partial differential equations on unstructured polytopal meshes (p. 81)

Contributed Talks

▷ Wed 4 December 2019

13:30 Markus Hegland (Australian National University)
Approximating functions of the precision matrix of Gaussian processes (p. 80)

14:45 Hailong Guo (The University of Melbourne)
Unfitted Nitsche's method for computing edge modes in photonic graphene (p. 80)

15:35 Oliver krzysik (Monash University)
Parallel time integration of hyperbolic PDEs (p. 80)

16:00 Michael Clarke (UNSW Sydney)
Uncertainty Quantification for the Linear Elastic equations (p. 79)

16:25 El Houssaine QUENJEL (Nice Sophia Antipolis University)
A stable finite volume scheme for nonlinear diffusion equations on general 2D meshes (p. 81)

16:50 Riya Aggarwal (The University of Newcastle)
Bragg Edge Neutron Transmission Strain Tomography using the Finite Element Method (p. 79)

17:15 Mark Joseph McGuinness (Victoria University of Wellington)
Pressure Buildup in Surtseyan Ejecta (p. 81)

17:40 Janosch Rieger (Monash University)
An approach to electrical impedance tomography in unknown domains (p. 81)

18:05 Martin Helmer (Australian National University)
Probabilistic Saturations and Alt's Problem in Mechanism Design (p. 80)

▷ Thu 5 December 2019

13:30 Thanh Tran (University of New South Wales)
A posteriori error estimation for nonlinear elliptic equations (p. 82)

13:55 Jerome Droniou (Monash University)
High-order numerical schemes for degenerate elliptic equations (p. 79)

14:20 Quoc Thong Le Gia (University of New South Wales)
A multiscale radial basis function method for severely ill-posed problems on spheres (p. 80)

Special Session 6: Dynamical Systems and Ergodic Theory

Organisers Jason Atnip, Andy Hammerlindl

Contributed Talks

▷ Wed 4 December 2019

13:30 Anoop Sivasankaran (Khalifa University of Science, Technology)
An empirical stability analysis of restricted Four-Body model (p. 85)

13:55 Divahar Jayaraman (The University of Adelaide)
Multiscale modelling enables prediction and simulation of floods and tsunamis (p. 84)

14:20 Courtney Rose Quinn (CSIRO)
Application of local attractor dimension to reduced space strongly coupled data assimilation for chaotic multiscale systems (p. 84)

14:45 Sam Jelbart (The University of Sydney)
Blowing-up essential singularities in singularly perturbed problems (p. 84)

16:00 Lachlan Smith (The University of Sydney)
Model reduction for the collective dynamics of networks of coupled oscillators (p. 85)

16:25 Gary Froyland (University of New South Wales)
A spectral approach for quenched limit theorems for random dynamical systems (p. 83)

16:50 Jason Atnip (University of New South Wales)
Conformal and Invariant Measures for Random Covering Weighted Systems (p. 83)

17:15 Fawwaz Batayneh (University of Queensland)
On the number of ergodic absolutely continuous invariant measures for higher dimensional random dynamical systems (p. 83)

17:40 Cecilia Gonzalez-Tokman (The University of Queensland)
Characterization and perturbations of the Lyapunov spectrum of a class of Perron-Frobenius operator cocycles (p. 83)

▷ Thu 5 December 2019

13:30 Kenneth James Palmer (National Taiwan University)
On Sil'nikov saddle-focus homoclinic orbits (p. 84)

13:55 Davide Ravotti (Monash University)
A geometric proof of Ratner's mixing rates for the horocycle flow (p. 85)

14:20 Sean Gasiorek (The University of Sydney)
On the Dynamics of Inverse Magnetic Billiards (p. 83)

Special Session 7: Financial mathematics

Organisers Ivan Guo, Zhou Zhou

Keynote Talks

▷ Wed 4 December 2019

15:35 Jan Obloj (University of Oxford)
Robust finance: data-driven approach to pricing, hedging and risk management (p. 87)

Contributed Talks

▷ Wed 4 December 2019

13:30 WEI Ning (Monash University)
Portfolio optimization with a prescribed terminal wealth density by deep optimal transport (p. 86)

13:55 Ivan Guo (Monash University)
Convex duality in robust hedging and optimal stopping problems (p. 86)

14:20 Kihun Nam (Monash University)
Non-Markovian Multidimensional Quadratic BSDE (p. 86)

14:45 Kenneth James Palmer (National Taiwan University)
Path Independence of Exotic Options and Convergence of Binomial Approximations (p. 87)

16:25 Shiyi Wang (Monash University)
Calibration of Local-Stochastic Volatility models by Optimal Transport (p. 87)

16:50 James Yang (The University of Sydney)
Multiscale Linear-Quadratic Stochastic Optimal Control (p. 87)

17:15 Edward Kim (The University of Sydney)
Vulnerable American Contracts with Extraneous Risks and Market Frictions (p. 86)

▷ Thu 5 December 2019

13:30 Libo Li (University of New South Wales)
Mean-field stable CIR process (p. 86)

13:55 Anna Aksamit (The University of Sydney)
Modelling additional information: filtration enlarged via a marked random time (p. 86)

14:20 Zhou Zhou (The University of Sydney)
On the Notions of Equilibria for Time-inconsistent Stopping Problems in Continuous Time (p. 87)

Special Session 8: Functional Analysis, Operator Algebra, Non-commutative Geometry

Organisers Galina Levitina, Geetika Verma

Contributed Talks

▷ Tue 3 December 2019

15:10 Hai-Long Her (The Australian National University)
Fredholm Property of Operators from 2D String Field Theory (p. 89)

15:35 David Leonard Brook (The University of Adelaide)
Higher twisted K-theory (p. 89)

16:00 Shaymaa Shawkat Kadhim Al-shakarchi (University of New South Wales)
Isomorphisms of $AC(\sigma)$ spaces. (p. 89)

▷ Fri 6 December 2019

13:30 Hendra Gunawan (Bandung Institute of Technology)
Some geometric constants for Morrey spaces (p. 89)

13:55 Roozbeh Hazrat (Western Sydney University)
The talented monoid of a directed graph (p. 89)

14:20 Geetika Verma (University of South Australia)
Inversion of operator pencils on Banach space using Jordan chains (p. 89)

Special Session 9: Geometric Analysis and Partial Differential Equations

Organisers Ting-Ying Chang, Todd Oliynyk

Contributed Talks

▷ Tue 3 December 2019

14:20 Jesse Gell-Redman (AMSI/University of Melbourne)
Global methods for semi-linear hyperbolic equations (p. 92)

15:10 Volker Schlue (The University of Melbourne)
On the stability of expanding black hole spacetimes (p. 93)

15:35 Christopher P Rock (UNSW Sydney)
Higher-order Cheeger and Buser inequalities, and a dynamics application (p. 93)

16:00 Yilin Ma (The University of Sydney)
The Semilinear Calderon Problem on Complex Manifolds (p. 93)

16:25 Florica Corina Cirstea (The University of Sydney)
Existence of sharp asymptotic profiles of singular solutions to an elliptic equation with a sign-changing nonlinearity (p. 91)

16:50 Yuhan Wu (University of Wollongong)
Short time existence for higher order curvature flows with and without boundary conditions (p. 94)

17:15 Nicholas Fewster-Young (University of South Australia)
Existence Results for Nonlinear Fractional Differential Equations (p. 92)

17:40 Maria Farcaseanu (The University of Sydney)
Singular quasilinear elliptic equations with gradient dependent nonlinearities (p. 92)

▷ Wed 4 December 2019

13:30 Serena Dipierro (The University of Western Australia)
A free boundary problem driven by the biharmonic operator (p. 92)

13:55 Paul Bryan (Macquarie University)
Hyperbolic 3-manifolds, embeddings and an invitation to the Cross Curvature Flow (p. 91)

14:20 Julie Clutterbuck (Monash University)
The fundamental gap in a negatively curved domain (p. 91)

14:45 Wenhui Shi (Monash University)
An epiperimetric inequality approach to the parabolic Signorini problem (p. 94)

15:35 Stephen Lynch (University of Tubingen)
A fully nonlinear flow of three-convex hypersurfaces (p. 93)

16:00 Romina Melisa Arroyo (University of Queensland)
The prescribed Ricci curvature problem for naturally reductive metrics on compact Lie groups: general theory (p. 91)

16:25 Artem Pulemotov (The University of Queensland)
The prescribed Ricci curvature problem for naturally reductive metrics on compact Lie groups: examples (p. 93)

16:50 Valentina-Mira Wheeler (University of Wollongong)
Counterexamples to graph preservation under mean curvature flow (p. 94)

17:15 Yong Wei (Australian National University)
Horospherically convex geometry in hyperbolic space and geometric flows (p. 94)

▷ Fri 6 December 2019

13:30 Enrico Valdinoci (The University of Western Australia)
Nonlocal minimal graphs in the plane are generically sticky (p. 94)

13:55 Zihua Guo (Monash University)
Ill-posedness of the Camassa-Holm and related equations in the critical space (p. 92)

14:20 Matthew Kevin Cooper (University of New England)
Symmetric biharmonic maps (p. 91)

15:10 Kwok-Kun Kwong (University of Wollongong)
Quantitative comparison theorems in geometry (p. 92)

15:35 Sevvandi Priyanvada Kandanaarachchi (Monash University)
Singularities of Axially Symmetric Volume Preserving Mean Curvature Flow (p. 92)

Special Session 10: Geometry including Differential Geometry

Organisers Ramiro Augusto Lafuente, Gerd Schmalz

Keynote Talks

▷ Thu 5 December 2019

13:55 A. Rod Gover (The University of Auckland)
Distinguished curves and integrability in Riemannian and conformal geometry (p. 95)

Contributed Talks

▷ Tue 3 December 2019

15:10 Artem Pulemotov (The University of Queensland)
The prescribed Ricci curvature equation on $(SU(2) \times SU(2))/U(1)_r$ (p. 96)

15:35 Romina Melisa Arroyo (University of Queensland)
On the signature of the Ricci curvature on nilmanifolds (p. 95)

16:00 Parsa Kavkani (The University of Adelaide)
Group Extensions and Bundle Gerbes (p. 95)

16:50 Gerd Schmalz (University of New England)
Kähler manifolds, Sasakian manifolds and generalised Taub-NUT solutions (p. 96)

17:15 Jeremy Nugent (University of New South Wales)
Superintegrable systems (p. 96)

▷ Thu 5 December 2019

13:30 Benjamin Blake McMillan (The University of Adelaide)
Conservation laws and parabolic Monge-Ampere equations (p. 95)

▷ Fri 6 December 2019

13:30 Yuri Nikolayevsky (La Trobe University)
On cylindricity of submanifolds of nonnegative Ricci curvature in a Minkowski space (p. 96)

13:55 Andreas Vollmer (University of New South Wales)
Second order superintegrable systems in arbitrary dimension (p. 97)

14:20 Krzysztof Krakowski (Cardinal Stefan Wyszynski University in Warsaw)
Rolling Symmetric Spaces (p. 95)

15:10 Marcos Origlia (Monash University)
Locally conformal Käler or symplectic structures on compact solvmanifolds (p. 96)

15:35 Owen Dearricott (The University of Melbourne)
Positive curvature in dimension seven (p. 95)

Special Session 11: Harmonic and Semiclassical Analysis

Organisers Zihua Guo

Contributed Talks

▷ Wed 4 December 2019

13:30 Xuan Duong (Macquarie University)
Sharp endpoint estimates for Schrödinger groups (p. 98)

13:55 Andrew Hassell (Australian National University)
A Fredholm approach to solving semilinear evolution equations (p. 98)

14:20 Alex Amenta (University of Bonn)
Vector-valued time-frequency analysis and the bilinear Hilbert transform (p. 98)

14:45 Volker Schlue (The University of Melbourne)
Scattering from infinity for semi-linear wave equations with weak null condition (p. 99)

15:35 Hamed Baghal Ghaffari (The University of Newcastle)
Construction of Multidimensional Prolate Spheroidal Wave Functions (p. 98)

16:00 Trang Thi Thien Nguyen (University of South Australia)
Non-homogeneous $T(1)$ theorem for singular integrals on product quasimetric spaces (p. 99)

16:25 Guillermo Javier Flores (Universidad Nacional de Cordoba)
Weighted Lebesgue and BMO norm inequalities for the Calderon and Hilbert operators (p. 98)

16:50 Fu Ken Ly (The University of Sydney)
An improved heat kernel bound for certain magnetic Schrodinger operators. (p. 99)

▷ Thu 5 December 2019

13:30 Lesley Ward (University of South Australia)
Product Hardy space theory on spaces of homogeneous type via orthonormal wavelet bases (p. 99)

13:55 Adam Sikora (Macquarie University)
Spectral multipliers without semigroup framework and application to random walks (p. 99)

14:20 Ji Li (Macquarie University)
Commutators of Cauchy-Szego type integrals for domains in C^n with minimal smoothness (p. 98)

Special Session 12: Inclusivity, diversity, and equity in mathematics

Organisers Amie Albrecht

Contributed Talks

▷ Tue 3 December 2019

15:10 Nalini Joshi (The University of Sydney)
A call to action (p. 101)

15:35 Benjamin Burton (University of Queensland)
Diversity at the Olympiads: Culture change in elite competition (p. 100)

16:00 Rowena Ball (The Australian National University)
Maths on country (p. 100)

16:25 Yudhistira Andersen Bunjamin (UNSW Sydney)
Equity considerations and design of mathematics outreach to schools (p. 100)

16:50 Julia Collins (Edith Cowan University)
CHOOSEMATHS: approaches to increasing female participation in advanced school mathematics (p. 100)

17:15 Valentina-Mira Wheeler (University of Wollongong)
Women in mathematics: one perspective on things that work so far and things that could be done in the future (p. 102)

▷ Wed 4 December 2019

13:30 Jessica Purcell (Monash University)
WIMSIG resources and initiatives to support careers (p. 102)

13:55 Daniel Mathews (Monash University)
Childcare at a large mathematical conference (p. 101)

14:20 Matthew Mack (Multiple Universities)
Improving accessibility in mathematics (p. 101)

14:45 Jacqui Ramagge (The University of Sydney)
Hiring for diversity (p. 102)

15:35 Heather Lonsdale (Curtin University)
Creating a critical mass of females in engineering mathematics classrooms (p. 101)

16:00 Collin Grant Phillips (The University of Sydney)
Responsive Techniques for Teaching Australian, Indigenous School Students: What Part Does Culture Play in Teaching Mathematics? (p. 102)

16:25 Asha Rao (Royal Melbourne Institute of Technology)
Nurture, gender differences and spatial abilities (p. 102)

16:50 Marcy Robertson (The University of Melbourne)
Improving the process of organizing conferences and special semesters (p. 102)

17:15 John Ormerod (The University of Sydney)
Descartes was wrong - The psychology of safety and its implications to equality, diversity, and inclusion (p. 101)

Special Session 13: Mathematical Biology

Organisers Pascal R Buenzli, Federico Frascoli

Keynote Talks

▷ Wed 4 December 2019

13:30 Michael Stumpf (The University of Melbourne)
The origins of heavy-tailed laws in biology (p. 105)

Contributed Talks

▷ Wed 4 December 2019

14:20 timothy hewson (University of Tasmania)
Graded rings of Markov invariants (p. 103)

14:45 Julia Shore (University of Tasmania)
The ancient Operational Code is embedded in the amino acid substitution matrix and aaRS phylogenies (p. 105)

15:35 Venta Terauds (University of Tasmania)
Symmetry and redundancy: choosing the right algebra for circular genome distance computations (p. 105)

16:00 Jeremy Sumner (University of Tasmania)
The Markov embedding problem from an algebraic perspective (p. 105)

16:25 Chad Mathew Clark (Western Sydney University)
An Algebraic Inversion-Deletion Model for Bacterial Genome Rearrangement (p. 103)

16:50 Joshua Stevenson (University of Tasmania)
Investigating rank-based approaches for inferring phylogenies (p. 105)

17:15 Adarsh Kumbhari (The University of Sydney)
Emergent signal processing in T cells via regulatory immune mechanisms (p. 104)

17:40 Pantea Pooladvand (The University of Sydney)
Modelling the Immune Response of CD4+ T cells: An intimate relationship between T cells and APCs (p. 104)

▷ Thu 5 December 2019

13:30 Sukhen Das (Jadavpur University)
Study of HIV in-host model through multi-pathways infection under different blockers : local and global analysis (p. 103)

13:55 Nandadulal Nandadulal Bairagi (Jadavpur University)
Pattern formation in a reaction-diffusion predator-prey-parasite model with prey infection under the influence of ecological and epidemiological parameters (p. 104)

14:20 Dipak Kumar Kesh (Jadavpur University)
Role of induced plant volatile and refuge in tritrophic model (p. 104)

▷ Fri 6 December 2019

13:30 Andrew Francis (Western Sydney University)
The space of tree-based phylogenetic networks (p. 103)

13:55 Lucy Ham (The University of Melbourne)
Extrinsic noise and heavy-tailed distributions in gene expression (p. 103)

Special Session 14: Mathematics Education

Organisers Deborah King

Contributed Talks

▷ Wed 4 December 2019

13:30 Poh Hillock (The University of Queensland)
Blended learning in a large first year mathematics course (p. 107)

13:55 Simon James (Deakin University)
Peer assessment and feedback - in class and online (p. 108)

14:20 Jennifer Palisse (The University of Melbourne)
Can Comparative Judgement Improve Student Performance with Rational Inequalities? (p. 108)

14:45 Joshua Capel (UNSW Sydney)
Learning and Teaching in a Digital world (p. 107)

16:00 Jelena Schmalz (University of New England)
Mathematics Enrichment Program at UNE – from Primary School to University (p. 109)

16:25 Renu Choudhary (Auckland University of Technology)
Empowering, Engaging and Enhancing Students' Learning using a Pen-Enabled Tablet (p. 107)

16:50 Diane Donovan (The University of Queensland)
Should I apply for a Teaching Award (p. 107)

▷ Fri 6 December 2019

13:30 Jennifer Palisse (The University of Melbourne)
Making the Grade: Do Mathematics Marks Matter to Women in STEM (p. 108)

13:55 Jonathan Kress (University of New South Wales)
Assessment in First Year Mathematics (p. 108)

14:20 Donald Shearman (Western Sydney University)
Does the Effectiveness of Mathematics and Statistics Support Depend on Students' Mathematical Background? (p. 109)

15:10 Deborah Jackson (La Trobe University)
Igniting interest, inspiration, investigation and intrigue within mathematics support. (p. 107)

15:35 Terence Mills (La Trobe University)
Can Kuhn revolutionise mathematics teaching? (p. 108)

Special Session 15: Mathematical Physics, Statistical Mechanics and Integrable systems

Organisers Nathan Clisby, Yang Shi, Zongzheng Zhou

Contributed Talks

▷ Tue 3 December 2019

14:20 Mark Holmes (The University of Melbourne)
Alignment percolation (p. 111)

15:10 Nicholas Beaton (The University of Melbourne)
Semi-flexible polymers in a strip with attractive walls (p. 110)

15:35 Makoto Narita (National Institute of Technology, Okinawa College)
On the global stability of Minkowski spacetimes in string theory (p. 112)

16:00 Ciprian Sorin Acatrinei (National Institute for Nuclear Physics and Engineering)
Noncommutative Field Theory and Discrete Orthogonal Polynomials (p. 110)

16:25 Brett Parker (Monash University)
The tropological vertex (p. 112)

16:50 Galina Levitina (University of New South Wales)
Spectral shift function via regularised determinant of higher order (p. 111)

▷ Wed 4 December 2019

13:30 Tony Guttmann (The University of Melbourne)
Some recent developments in self-avoiding walks (p. 111)

13:55 Abrahim Steve Nasrawi (Monash University)
The length of self-avoiding walks on the complete graph (p. 112)

14:20 Seamus Albion (The University of Queensland)
Selberg integrals and the AGT conjecture (p. 110)

14:45 Katherine Anne Seaton (La Trobe University)
Rolling, rolling, rolling (p. 113)

15:35 Anas Abdur Rahman (The University of Melbourne)
Recursions on the Moments of Random Matrix Ensembles (p. 112)

16:00 Allan Trinh (The University of Melbourne)
Finite size corrections at the hard edge for the Laguerre β ensemble (p. 113)

16:25 Jiyuan Zhang (The University of Melbourne)
Spherical transform and randomised Horn problem (p. 113)

16:50 Peter Forrester (The University of Melbourne)
Further random matrix fermi gas analogies (p. 110)

17:15 Mario Kieburg (The University of Melbourne)
Matrix products involving Hermitian Random Matrices (p. 111)

17:40 Jesper Ipsen (The University of Melbourne)
Large complex systems beyond the instability threshold (p. 111)

▷ Thu 5 December 2019

13:30 Dinh Tran (The University of Sydney)
Hierarchies of q-discrete second, third and fourth Painlevé equations and their properties (p. 113)

13:55 Nalini Joshi (The University of Sydney)
Painlev'e VI in Okamoto's Space (p. 111)

14:20 Pieter Roffelsen (International School for Advanced Studies (SISSA))
On the asymptotic distribution of roots of the generalised Hermite polynomials (p. 113)

▷ Fri 6 December 2019

13:30 Margaret Reid (Swinburne University of Technology)
Quantum Entanglement, Schrodinger's cat, and the Q-function phase-space model of reality (p. 112)

13:55 Thomas Quella (The University of Melbourne)
Conformal field theory and the non-abelian SU(2) level k chiral spin liquid (p. 112)

14:20 Alexandr Garbali (The University of Melbourne)
A lattice model with the symmetry of the quantum toroidal gl_1 *algebra* (p. 110)

15:10 Laurence Field (Australian National University)
Escape estimates for SLE (p. 110)

15:35 Timothy Garoni (Monash University)
Critical speeding up in dynamical percolation (p. 110)

16:00 Zongzheng Zhou (Monash University)
The coupling time of the Ising Glauber dynamics (p. 114)

Special Session 16: Number Theory and Algebraic Geometry

Organisers Christian Haesemeyer, Liangyi Zhao

Keynote Talks

▷ Wed 4 December 2019

13:30 Peng Gao (Beihang University)
Lower order terms for the one level density of quadratic Hecke L-functions in the Gaussian field (p. 115)

Contributed Talks

▷ Tue 3 December 2019

15:10 Sean Lynch (UNSW Sydney)
The prime ideal theorem in noncommutative arithmetic (p. 116)

15:35 Forrest James Francis (Australian Defence Force Academy)
Burgess' Bound and kth Power Non-residues (p. 115)

16:00 Timothy Trudgian (UNSW Canberra)
When primes are just too hard... (p. 116)

16:25 Matteo Bordignon (University of New South Wales Canberra)
Explicit Pólya-Vinogradov for primitive characters and large moduli (p. 115)

16:50 Aleksander Simonic (University of New South Wales Canberra)
On Selberg's zero density estimate and related results (p. 116)

17:15 Ethan Simpson Lee (UNSW Canberra)
On the zero-free region for the Dedekind zeta-function (p. 116)

▷ Wed 4 December 2019

14:20 Benjamin Moore (The University of Adelaide)
Quartic Gauss sums and twisted reciprocity (p. 116)

14:45 Kam Hung Yau (University of New South Wales)
A relaxation of Goldbach's conjecture (p. 117)

15:35 Michaela Cully-Hugill (University of New South Wales Canberra)
Explicit results on the sum of a divisor function (p. 115)

16:00 Shehzad Shabbirbhai Hathi (UNSW Canberra)
Biases, oscillations, and first sign changes in arithmetic functions (p. 116)

16:25 Ayreena Bakhtawar (La Trobe University)
Improvements to Dirichlet's theorem in Diophantine approximation (p. 115)

▷ Thu 5 December 2019

13:30 James Borger (Australian National University)
The etale fundamental group of semirings (p. 115)

13:55 Thomas Morrill (UNSW Canberra)
A combinatoric proof of Jackson's summation (p. 116)

14:20 Chenyan Wu (The University of Melbourne)
Involutive property and irreducibility of theta correspondence (p. 117)

Special Session 17: Optimisation

Organisers Andrew Craig Eberhard, Ryan Loxton, Vera Roshchina

Keynote Talks

▷ Tue 3 December 2019

17:15 Jie Sun (Curtin University)
Stochastic Variational Inequalities, Nash Equilibria under Uncertainty, and the Progressive Hedging Algorithm (p. 121)

▷ Fri 6 December 2019

13:30 Alexander Ioffe (Technion, Israel Institute of Technology)
On the strong minimum in optimal control. A view from variational analysis. (p. 119)

Contributed Talks

▷ Tue 3 December 2019

14:20 Alexander Kruger (Federation University Australia)
About the Radius of Metric Subregularity (p. 119)

15:10 Thi Hoa Bui (Federation University Australia)
Zero Duality Gap via Abstract Convexity (p. 118)

15:35 Asghar Moeini (Curtin University)
Strong Valid Inequalities Identification for Mixed Integer Programs with a given Set of Solutions (p. 119)

16:00 Cuong Nguyen Duy (Federation University Australia)
Characterizations of Robinson regularity properties of implicit multifunctions and applications (p. 120)

16:25 Neil Kristofer Dizon (The University of Newcastle)
Projection algorithms in wavelet construction as a feasibility problem (p. 118)

16:50 Ryan Loxton (Curtin University)
Minimizing Control Volatility for Nonlinear Systems with Smooth Input Signals (p. 119)

▷ Thu 5 December 2019

13:30 Nadia Sukhorukova (Swinburne University of Technology)
Remez method applicability in Chebyshev approximation problems (p. 121)

13:55 James Saunderson (Monash University)
Certifying polynomial nonnegativity via hyperbolic optimisation (p. 120)

14:20 Scott Boivin Lindstrom (Hong Kong Polytechnic University)
On the Projected Polar Proximal Point Algorithm (p. 119)

▷ Fri 6 December 2019

14:20 Vladimir Gaitsgory (Macquarie University)
Linear Programming Based Optimality Conditions for Long Run Average Optimal Control Problems (p. 118)

15:10 Andrew Craig Eberhard (RMIT University)
A Progressive Hedging - Feasibility Pump for Stochastic Integer Programming (p. 118)

15:35 Janosch Rieger (Monash University)
A linear programming approach to approximating the infinite time reachable set of strictly stable linear control systems (p. 120)

16:00 Julien Ugon (Deakin University)
Best chebyshev approximation by rational functions (p. 121)

16:25 Vera Roshchina (UNSW Sydney)
Optimal selling mechanism design in the presence of budget constraints (p. 120)

Special Session 18: Probability Theory and Stochastic Processes

Organisers Andrea Collevecchio, Jie Yen Fan, Giang Nguyen

Keynote Talks

▷ Tue 3 December 2019

15:10 Robert Charles Griffiths (Monash University)
Forward and Backward in time. Population Genetics Stochastic Process Models (p. 123)

Contributed Talks

▷ Tue 3 December 2019

14:20 Angus Hamilton Lewis (The University of Adelaide)
Interpretation of approximations to infinitesimal generators as Quasi-Birth-and-Death-like processes (p. 124)

16:00 Han Gan (Northwestern University)
Poisson-Dirichlet and Ewens sampling formula approximations for Wright-Fisher models (p. 123)

16:25 Alejandro Francisco Ramirez (Catholic University of Chile)
Exponential decay for the exit probability from slabs of random walk in random environment (p. 125)

16:50 Zongzheng Zhou (Monash University)
Information percolation and the coupling time of the stochastic Ising model (p. 125)

17:15 Andrea Collevecchio (Monash University)
Strongly Vertex-Reinforced Jump Processes localizes on 3 points (p. 122)

17:40 adam nie (Australian National University)
Weak Subordination of Lévy processes on Hilbert spaces (p. 124)

▷ Wed 4 December 2019

13:30 Dareen Omari (La Trobe University)
Non-central asymptotics for functionals of strong-weak dependent vector random fields (p. 125)

13:55 Zdravko Botev (University of New South Wales)
Novel Methods for Model Selection in Linear Regression (p. 122)

14:20 Libo Li (University of New South Wales)
Positivity Preserving Numerical Schemes for Jump-extended CIR/CEV Process (p. 124)

14:45 Kais Hamza (Monash University)
Matching marginals and sums (p. 123)

15:35 Jie Yen Fan (Monash University)
Local Brownian Motions (p. 122)

16:00 Kevin Lu (Australian National University)
Multivariate Lévy-driven Ornstein-Uhlenbeck processes Using Weak Subordination (p. 124)

16:25 Laurence Field (Australian National University)
Brownian motion in multiply connected planar domains (p. 123)

16:50 Illia Donhauzer (La Trobe University)
On some asymptotics of functionals of long-range dependent random fields. (p. 122)

17:15 Tareq Alodat (La Trobe University)
Limit theorems for filtered long-range dependent random fields (p. 122)

▷ Fri 6 December 2019

13:30 Peter Taylor (The University of Melbourne)
A model for cell proliferation in a developing organism (p. 125)

13:55 Fima Klebaner (Monash University)
Effect of small noise leading to random initial conditions in dynamical systems (p. 123)

14:20 Andriy Olenko (La Trobe University)
Stochastic hyperbolic diffusion equations on the sphere (p. 125)

15:10 Hermanus Marinus Jansen (The University of Queensland)
The asymptotic behaviour of the time-varying supermarket model (p. 123)

15:35 Nigel Bean (The University of Adelaide)
Yaglom Limit for Stochastic Fluid Models (p. 122)

Special Session 19: Representation Theory

Organisers Valentin Buciumas, Ting Xue

Keynote Talks

▷ Wed 4 December 2019

16:00 Kari Vilonen (The University of Melbourne)
Real Groups, Hodge Theory, and the Langlands duality (p. 128)

Contributed Talks

▷ Wed 4 December 2019

13:30 Anna Romanov (The University of Sydney)
Contravariant forms on Whittaker modules (p. 128)

13:55 Kevin Coulembier (The University of Sydney)
Classification of blocks in category O (p. 127)

14:20 David Ridout (The University of Melbourne)
Representations of affine vertex algebras: beyond category $\mathcal{O}$ (p. 127)

14:45 Zachary Fehily (The University of Melbourne)
Classification of relaxed highest-weight modules for admissible level Bershadsky-Polyakov algebras (p. 127)

15:35 Masoud Kamgarpour (University of Queensland)
Geometric Langlands for Wild Hypergeometric Sheaves (p. 127)

16:50 Linyuan Liu (The University of Sydney)
Cohomology of line bundles on flag varieties (p. 127)

17:15 Yusra Naqvi (The University of Sydney)
A gallery model for affine flag varieties (p. 127)

17:40 Travis Scrimshaw (The University of Queensland)
Crystal structures for canonical Grothendieck functions (p. 128)

Special Session 20: Topology

Organisers Diarmuid Crowley, Brett Parker

Keynote Talks

▷ Tue 3 December 2019

15:10 Jessica Purcell (Monash University)
The triangulation complexity of fibred 3-manifolds (p. 131)

Contributed Talks

▷ Tue 3 December 2019

16:00 Boris Lishak (The University of Sydney)
Combinatorial isotopies (p. 130)

16:25 Kelly Maggs (The Australian National University)
Homotopy Merge Trees in Topological Data Analysis (p. 130)

16:50 Sophie Ham (Monash University)
Geometric Triangulations and Highly Twisted Knots (p. 129)

17:15 Craig Hodgson (The University of Melbourne)
Constructing geometric structures using twisted tetrahedra (p. 130)

▷ Wed 4 December 2019

13:30 Daniel Mathews (Monash University)
Geometry and physics of circle packings (p. 130)

13:55 Anupam Chaudhuri (Monash University)
Local topological recursion governs the enumeration of lattice points in $\overline{\mathcal{M}}_{g,n}$ (p. 129)

14:20 Mehdi Tavakol (The University of Melbourne)
Tautological classes with twisted coefficients (p. 131)

14:45 Ellena Moskovsky (Monash University)
On the topological recursion for double Hurwitz numbers (p. 130)

15:35 Csaba Nagy (The University of Melbourne)
The Sullivan-conjecture in complex dimension 4 (p. 131)

16:00 Grace Garden (The University of Sydney)
The Mapping Class Group Action on the Character Variety of the Once-Punctured Torus (p. 129)

16:25 Michael Swaddle (AMSI/University of Melbourne)
Airy structures and topological recursion (p. 131)

16:50 Guo Chuan Thiang (The University of Adelaide)
T-dualities of orbifolds (p. 132)

17:15 Wee chaimanowong (AMSI/University of Melbourne)
Deformation of Curves and Topological Recursions (p. 129)

17:40 Norman Do (Monash University)
On the Goulden–Jackson–Vakil conjecture for double Hurwitz numbers (p. 129)

▷ Fri 6 December 2019

13:30 Marcy Robertson (The University of Melbourne)
Modelling homology operations in string topology (p. 131)

13:55 Martin Helmer (Australian National University)
Complex Linking Numbers for Strata of Varieties (p. 130)

14:20 TriThang Tran (The University of Melbourne)
Braids and shuffle algebras (p. 132)

15:10 Xing Gu (AMSI/University of Melbourne)
The topological period-index problem (p. 129)

15:35 David Roberts (The University of Adelaide)
A descent-theoretic proof of a theorem of Serre (p. 131)

16:00 Paul Norbury (The University of Melbourne)
Polynomial relations among kappa classes on the moduli space of curves (p. 131)

Tue 3 December 2019

▪ Summary timetable

When	What	Where
09:00–10:30	Opening Ceremony/Prize Giving	South 1
10:30–11:00	Morning tea	
11:00–12:00	**Plenary:** Krieger	South 1
12:00–13:30	Lunch	
13:30–14:20	**Plenary:** Sikora	G81
14:20–14:45	6 special session talks	Various locations (see below)
14:45–15:10	Afternoon Tea	
15:10–16:00	11 special session talks	Various locations (see below)
15:35–16:00	7 special session talks	Various locations (see below)
16:00–16:25	11 special session talks	Various locations (see below)
16:25–16:50	9 special session talks	Various locations (see below)
16:50–17:15	10 special session talks	Various locations (see below)
17:15–17:40	9 special session talks	Various locations (see below)
17:40–18:05	3 special session talks	Various locations (see below)

▪ Special Sessions

3. Applied and Industrial Mathematics

189

14:20 Dylan Harries (CSIRO)
Applications of temporally regularised matrix factorisations to the analysis of climate data (p. 69)

15:10 Terry O'Kane (CSIRO)
Simple Markovian closures for inhomogeneous turbulence (p. 69)

16:00 Samithree Rajapaksha (Monash University)
Approximating Link Travel Time Distributions (p. 70)

16:25 Vassili Kitsios (CSIRO)
Ensemble transform Kalman filter estimation of thermodynamic parameters in a coupled general circulation model (p. 69)

16:50 Sevvandi Priyanvada Kandanaarachchi (Monash University)
DOBIN: dimension reduction for outlier detection (p. 69)

17:15 Lele (Joyce) Zhang (The University of Melbourne)
Courier route optimization with unloading bays information and reservation systems (p. 70)

5. Combinatorics and Graph Theory

G56

14:20 Benjamin Jones (Monash University)
Excluded minors for classes of binary functions (p. 76)

15:10 Andrii Arman (Monash University)
Generation of random graphs with given degrees (p. 73)

16:00 Rui Zhang (Monash University)
Bounded Difference Inequalities for Graph-Dependent Random Variables (p. 78)

16:25 Matthias Fresacher (University of Adelaide)
Learning Large Random Graphs Via Group Queries (p. 75)

16:50 Angus Southwell (Monash University)
Counting automorphisms of random trees with martingales (p. 77)

17:15 Richard Brak (The University of Melbourne)
Universal Bijections for Positive Algebraic Structures (p. 73)

17:40 Kevin Limanta (University of New South Wales)
A curious bijection between Dyck paths (p. 76)

9. Functional Analysis, Operator Algebra, Non-commutative Geometry

134

15:10 Hai-Long Her (The Australian National University)
Fredholm Property of Operators from 2D String Field Theory (p. 89)

15:35 David Leonard Brook (The University of Adelaide)
Higher twisted K-theory (p. 89)

16:00 Shaymaa Shawkat Kadhim Al-shakarchi (University of New South Wales)
Isomorphisms of $AC(\sigma)$ spaces. (p. 89)

10. Geometric Analysis and Partial Differential Equations

136

14:20 Jesse Gell-Redman (AMSI/University of Melbourne)
Global methods for semi-linear hyperbolic equations (p. 92)

15:10 Volker Schlue (The University of Melbourne)
On the stability of expanding black hole spacetimes (p. 93)

15:35 Christopher P Rock (UNSW Sydney)
Higher-order Cheeger and Buser inequalities, and a dynamics application (p. 93)

16:00 Yilin Ma (The University of Sydney)
The Semilinear Calderon Problem on Complex Manifolds (p. 93)

16:25 Florica Corina Cirstea (The University of Sydney)
Existence of sharp asymptotic profiles of singular solutions to an elliptic equation with a sign-changing nonlinearity (p. 91)

16:50 Yuhan Wu (University of Wollongong)
Short time existence for higher order curvature flows with and without boundary conditions (p. 94)

17:15 Nicholas Fewster-Young (University of South Australia)
Existence Results for Nonlinear Fractional Differential Equations (p. 92)

17:40 Maria Farcaseanu (The University of Sydney)
Singular quasilinear elliptic equations with gradient dependent nonlinearities (p. 92)

11. Geometry including Differential Geometry

186

15:10 Artem Pulemotov (The University of Queensland)
The prescribed Ricci curvature equation on $(SU(2) \times SU(2))/U(1)_r$ (p. 96)

15:35 Romina Melisa Arroyo (University of Queensland)
On the signature of the Ricci curvature on nilmanifolds (p. 95)

16:00 Parsa Kavkani (The University of Adelaide)
Group Extensions and Bundle Gerbes (p. 95)

16:50 Gerd Schmalz (University of New England)
Kähler manifolds, Sasakian manifolds and generalised Taub-NUT solutions (p. 96)

17:15 Jeremy Nugent (University of New South Wales)
Superintegrable systems (p. 96)

13. Inclusivity, diversity, and equity in mathematics

G61

15:10 Nalini Joshi (The University of Sydney)
A call to action (p. 101)

15:35 Benjamin Burton (University of Queensland)
Diversity at the Olympiads: Culture change in elite competition (p. 100)

16:00 Rowena Ball (The Australian National University)
Maths on country (p. 100)

16:25 Yudhistira Andersen Bunjamin (UNSW Sydney)
Equity considerations and design of mathematics outreach to schools (p. 100)

16:50 Julia Collins (Edith Cowan University)
CHOOSEMATHS: approaches to increasing female participation in advanced school mathematics (p. 100)

17:15 Valentina-Mira Wheeler (University of Wollongong)
Women in mathematics: one perspective on things that work so far and things that could be done in the future (p. 102)

16. Mathematical Physics, Statistical Mechanics and Integrable systems

G55

14:20 Mark Holmes (The University of Melbourne)
Alignment percolation (p. 111)

15:10 Nicholas Beaton (The University of Melbourne)
Semi-flexible polymers in a strip with attractive walls (p. 110)

15:35 Makoto Narita (National Institute of Technology, Okinawa College)
On the global stability of Minkowski spacetimes in string theory (p. 112)

16:00 Ciprian Sorin Acatrinei (National Institute for Nuclear Physics and Engineering)
Noncommutative Field Theory and Discrete Orthogonal Polynomials (p. 110)

16:25 Brett Parker (Monash University)
The tropological vertex (p. 112)

16:50 Galina Levitina (University of New South Wales)
Spectral shift function via regularised determinant of higher order (p. 111)

17. Number Theory and Algebraic Geometry

G57

15:10 Sean Lynch (UNSW Sydney)
The prime ideal theorem in noncommutative arithmetic (p. 116)

15:35 Forrest James Francis (Australian Defence Force Academy)
Burgess' Bound and kth Power Non-residues (p. 115)

16:00 Timothy Trudgian (UNSW Canberra)
When primes are just too hard... (p. 116)

16:25 Matteo Bordignon (University of New South Wales Canberra)
Explicit Pólya-Vinogradov for primitive characters and large moduli (p. 115)

16:50 Aleksander Simonic (University of New South Wales Canberra)
On Selberg's zero density estimate and related results (p. 116)

17:15 Ethan Simpson Lee (UNSW Canberra)
On the zero-free region for the Dedekind zeta-function (p. 116)

18. Optimisation

188

14:20 Alexander Kruger (Federation University Australia)
About the Radius of Metric Subregularity (p. 119)

15:10 Thi Hoa Bui (Federation University Australia)
Zero Duality Gap via Abstract Convexity (p. 118)

15:35 Asghar Moeini (Curtin University)
Strong Valid Inequalities Identification for Mixed Integer Programs with a given Set of Solutions (p. 119)

16:00 Cuong Nguyen Duy (Federation University Australia)
Characterizations of Robinson regularity properties of implicit multifunctions and applications (p. 120)

16:25 Neil Kristofer Dizon (The University of Newcastle)
Projection algorithms in wavelet construction as a feasibility problem (p. 118)

16:50 Ryan Loxton (Curtin University)
Minimizing Control Volatility for Nonlinear Systems with Smooth Input Signals (p. 119)

17:15 Jie Sun (Curtin University)
Stochastic Variational Inequalities, Nash Equilibria under Uncertainty, and the Progressive Hedging Algorithm (p. 121)

19. Probability Theory and Stochastic Processes

183

14:20 Angus Hamilton Lewis (The University of Adelaide)
Interpretation of approximations to infinitesimal generators as Quasi-Birth-and-Death-like processes (p. 124)

15:10 Robert Charles Griffiths (Monash University)
Forward and Backward in time. Population Genetics Stochastic Process Models (p. 123)

16:00 Han Gan (Northwestern University)
Poisson-Dirichlet and Ewens sampling formula approximations for Wright-Fisher models (p. 123)

16:25 Alejandro Francisco Ramirez (Catholic University of Chile)
Exponential decay for the exit probability from slabs of random walk in random environment (p. 125)

16:50 Zongzheng Zhou (Monash University)
Information percolation and the coupling time of the stochastic Ising model (p. 125)

17:15 Andrea Collevecchio (Monash University)
Strongly Vertex-Reinforced Jump Processes localizes on 3 points (p. 122)

17:40 adam nie (Australian National University)
Weak Subordination of Lévy processes on Hilbert spaces (p. 124)

21. Topology

137

15:10 Jessica Purcell (Monash University)
The triangulation complexity of fibred 3-manifolds (p. 131)

16:00 Boris Lishak (The University of Sydney)
Combinatorial isotopies (p. 130)

16:25 Kelly Maggs (The Australian National University)
Homotopy Merge Trees in Topological Data Analysis (p. 130)

16:50 Sophie Ham (Monash University)
Geometric Triangulations and Highly Twisted Knots (p. 129)

17:15 Craig Hodgson (The University of Melbourne)
Constructing geometric structures using twisted tetrahedra (p. 130)

Wed 4 December 2019

▪ Summary timetable

When	What	Where
09:00–10:00	**Plenary:** Joshi	G81
10:00–10:30	Morning tea	
10:30–11:30	**Plenary:** an Huef	G81
11:30–12:30	Debate	G81
12:30–13:30	Lunch	
13:30–13:55	16 special session talks	Various locations (see below)
13:55–14:20	13 special session talks	Various locations (see below)
14:20–14:45	15 special session talks	Various locations (see below)
14:45–15:10	16 special session talks	Various locations (see below)
15:10–15:35	Afternoon Tea	
15:35–16:00	14 special session talks	Various locations (see below)
16:00–16:25	15 special session talks	Various locations (see below)
16:25–16:50	15 special session talks	Various locations (see below)
16:50–17:15	15 special session talks	Various locations (see below)
17:15–17:40	12 special session talks	Various locations (see below)
17:40–18:05	8 special session talks	Various locations (see below)
18:05–18:30	1 special session talks	Various locations (see below)

▪ Special Sessions

2. Algebra

G58

13:30 Jeroen Schillewaert (University of Auckland)
On exceptional Lie geometries (p. 68)

13:55 Subhrajyoti Saha (Monash University)
Skeleton groups and their isomorphism problem (p. 67)

14:20 Primoz Moravec (University of Ljubljana)
Gaps in probabilities of satisfying some commutator identities (p. 66)

14:45 Michal Ferov (The University of Newcastle)
Separating conjugacy classes in wreath products of groups (p. 65)

15:35 Marcos Origlia (Monash University)
Simply transitive NIL-affine actions of solvable Lie groups (p. 67)

16:00 Santiago Barrera Acevedo (Monash University)
Cocyclic Hadamard matrices of order 4p (p. 65)

16:25 James Mathew Koussas (La Trobe University)
Varieties of semiassociative relation algebras (p. 66)

16:50 Lauren Thornton (University of the Sunshine Coast)
On properties of descending chains (p. 68)

17:15 Alejandra Garrido (The University of Newcastle)
Locally compact topological full groups are locally finite (p. 65)

17:40 Colin David Reid (The University of Newcastle)
Locally compact piecewise full groups of homeomorphisms of the Cantor set (p. 67)

4. Category Theory

188

13:30 Richard Garner (Macquarie University)
The free tangent category on an affine connection (p. 71)

14:20 Michelle Strumila (The University of Melbourne)
Graphical Sets and Mapping Class Groups (p. 72)

14:45 Giacomo Tendas (Macquarie University)
Regular Theories Enriched Over Finitary Varieties (p. 72)

15:35 Martina Rovelli (The Australian National University)
An embedding of the homotopy theory of 2-categories into that of 2-complicial sets (p. 71)

16:00 Bryce Clarke (Macquarie University)
Characterising split opfibrations using lenses (p. 71)

16:25 Bregje Pauwels (The University of Sydney)
t-structures and approximable triangulated categories (p. 71)

16:50 David Roberts (The University of Adelaide)
Localising by spans and cospans, and functoriality of associated algebras (p. 71)

5. Combinatorics and Graph Theory

G56

13:30 Nicholas Cavenagh (University of Waikato)
Heffter Arrays with compatible and simple orderings (p. 73)

13:55 Ajani De Vas Gunasekara (Monash University)
On determining when small embeddings of partial Steiner triple systems exist (p. 74)

14:20 Adam Gowty (Monash University)
New bounds on the maximum size of Sperner partition systems (p. 75)

14:45 Daniel Horsley (Monash University)
Generating digraphs with derangements (p. 76)

15:35 Guillermo Pineda-Villavicencio (Deakin University)
Minkowski decompositions of polytopes via geometric graphs (p. 77)

16:00 Michael Payne (La Trobe University)
Geometric hypergraph colouring problems (p. 77)

16:25 Adam Mammoliti (Monash University)
On the Cyclic Matching sequenceablility of regular graphs (p. 76)

16:50 Michael James Gill (Monash University)
Perfect 1-factorisations of K_{16} (p. 75)

17:15 William Crawford (Monash University)
Properties of the polytope of polystochastic matrices (p. 74)

17:40 Graham Farr (Monash University)
Some problems suggested by the Online Graph Atlas project (p. 74)

6. Computational Mathematics

189

13:30 Markus Hegland (Australian National University)
Approximating functions of the precision matrix of Gaussian processes (p. 80)

13:55 Gianmarco Manzini (Consiglio Nazionale delle Ricerche (CNR) - Italy)
The Virtual Element Method for solving partial differential equations on unstructured polytopal meshes (p. 81)

14:45 Hailong Guo (The University of Melbourne)
Unfitted Nitsche's method for computing edge modes in photonic graphene (p. 80)

15:35 Oliver krzysik (Monash University)
Parallel time integration of hyperbolic PDEs (p. 80)

16:00 Michael Clarke (UNSW Sydney)
Uncertainty Quantification for the Linear Elastic equations (p. 79)

16:25 El Houssaine QUENJEL (Nice Sophia Antipolis University)
A stable finite volume scheme for nonlinear diffusion equations on general 2D meshes (p. 81)

16:50 Riya Aggarwal (The University of Newcastle)
Bragg Edge Neutron Transmission Strain Tomography using the Finite Element Method (p. 79)

17:15 Mark Joseph McGuinness (Victoria University of Wellington)
Pressure Buildup in Surtseyan Ejecta (p. 81)

17:40 Janosch Rieger (Monash University)
An approach to electrical impedance tomography in unknown domains (p. 81)

18:05 Martin Helmer (Australian National University)
Probabilistic Saturations and Alt's Problem in Mechanism Design (p. 80)

7. Dynamical Systems and Ergodic Theory

123

13:30 Anoop Sivasankaran (Khalifa University of Science, Technology)
An empirical stability analysis of restricted Four-Body model (p. 85)

13:55 Divahar Jayaraman (The University of Adelaide)
Multiscale modelling enables prediction and simulation of floods and tsunamis (p. 84)

14:20 Courtney Rose Quinn (CSIRO)
Application of local attractor dimension to reduced space strongly coupled data assimilation for chaotic multiscale systems (p. 84)

14:45 Sam Jelbart (The University of Sydney)
Blowing-up essential singularities in singularly perturbed problems (p. 84)

16:00 Lachlan Smith (The University of Sydney)
Model reduction for the collective dynamics of networks of coupled oscillators (p. 85)

16:25 Gary Froyland (University of New South Wales)
A spectral approach for quenched limit theorems for random dynamical systems (p. 83)

16:50 Jason Atnip (University of New South Wales)
Conformal and Invariant Measures for Random Covering Weighted Systems (p. 83)

17:15 Fawwaz Batayneh (University of Queensland)
On the number of ergodic absolutely continuous invariant measures for higher dimensional random dynamical systems (p. 83)

17:40 Cecilia Gonzalez-Tokman (The University of Queensland)
Characterization and perturbations of the Lyapunov spectrum of a class of Perron-Frobenius operator cocycles (p. 83)

8. Financial mathematics

182

13:30 WEI Ning (Monash University)
Portfolio optimization with a prescribed terminal wealth density by deep optimal transport (p. 86)

13:55 Ivan Guo (Monash University)
Convex duality in robust hedging and optimal stopping problems (p. 86)

14:20 Kihun Nam (Monash University)
Non-Markovian Multidimensional Quadratic BSDE (p. 86)

14:45 Kenneth James Palmer (National Taiwan University)
Path Independence of Exotic Options and Convergence of Binomial Approximations (p. 87)

15:35 Jan Obloj (University of Oxford)
Robust finance: data-driven approach to pricing, hedging and risk management (p. 87)

16:25 Shiyi Wang (Monash University)
Calibration of Local-Stochastic Volatility models by Optimal Transport (p. 87)

16:50 James Yang (The University of Sydney)
Multiscale Linear-Quadratic Stochastic Optimal Control (p. 87)

17:15 Edward Kim (The University of Sydney)
Vulnerable American Contracts with Extraneous Risks and Market Frictions (p. 86)

10. Geometric Analysis and Partial Differential Equations

136

13:30 Serena Dipierro (The University of Western Australia)
A free boundary problem driven by the biharmonic operator (p. 92)

13:55 Paul Bryan (Macquarie University)
Hyperbolic 3-manifolds, embeddings and an invitation to the Cross Curvature Flow (p. 91)

14:20 Julie Clutterbuck (Monash University)
The fundamental gap in a negatively curved domain (p. 91)

14:45 Wenhui Shi (Monash University)
An epiperimetric inequality approach to the parabolic Signorini problem (p. 94)

15:35 Stephen Lynch (University of Tubingen)
A fully nonlinear flow of three-convex hypersurfaces (p. 93)

16:00 Romina Melisa Arroyo (University of Queensland)
The prescribed Ricci curvature problem for naturally reductive metrics on compact Lie groups: general theory (p. 91)

16:25 Artem Pulemotov (The University of Queensland)
The prescribed Ricci curvature problem for naturally reductive metrics on compact Lie groups: examples (p. 93)

16:50 Valentina-Mira Wheeler (University of Wollongong)
Counterexamples to graph preservation under mean curvature flow (p. 94)

17:15 Yong Wei (Australian National University)
Horospherically convex geometry in hyperbolic space and geometric flows (p. 94)

12. Harmonic and Semiclassical Analysis

134

13:30 Xuan Duong (Macquarie University)
Sharp endpoint estimates for Schrödinger groups (p. 98)

13:55 Andrew Hassell (Australian National University)
A Fredholm approach to solving semilinear evolution equations (p. 98)

14:20 Alex Amenta (University of Bonn)
Vector-valued time-frequency analysis and the bilinear Hilbert transform (p. 98)

14:45 Volker Schlue (The University of Melbourne)
Scattering from infinity for semi-linear wave equations with weak null condition (p. 99)

15:35 Hamed Baghal Ghaffari (The University of Newcastle)
Construction of Multidimensional Prolate Spheroidal Wave Functions (p. 98)

16:00 Trang Thi Thien Nguyen (University of South Australia)
Non-homogeneous $T(1)$ theorem for singular integrals on product quasimetric spaces (p. 99)

16:25 Guillermo Javier Flores (Universidad Nacional de Cordoba)
Weighted Lebesgue and BMO norm inequalities for the Calderon and Hilbert operators (p. 98)

16:50 Fu Ken Ly (The University of Sydney)
An improved heat kernel bound for certain magnetic Schrodinger operators. (p. 99)

13. Inclusivity, diversity, and equity in mathematics

G61

13:30 Jessica Purcell (Monash University)
WIMSIG resources and initiatives to support careers (p. 102)

13:55 Daniel Mathews (Monash University)
Childcare at a large mathematical conference (p. 101)

14:20 Matthew Mack (Multiple Universities)

Improving accessibility in mathematics (p. 101)

14:45 Jacqui Ramagge (The University of Sydney)
Hiring for diversity (p. 102)

15:35 Heather Lonsdale (Curtin University)
Creating a critical mass of females in engineering mathematics classrooms (p. 101)

16:00 Collin Grant Phillips (The University of Sydney)
Responsive Techniques for Teaching Australian, Indigenous School Students: What Part Does Culture Play in Teaching Mathematics? (p. 102)

16:25 Asha Rao (Royal Melbourne Institute of Technology)
Nurture, gender differences and spatial abilities (p. 102)

16:50 Marcy Robertson (The University of Melbourne)
Improving the process of organizing conferences and special semesters (p. 102)

17:15 John Ormerod (The University of Sydney)
Descartes was wrong - The psychology of safety and its implications to equality, diversity, and inclusion (p. 101)

14. Mathematical Biology

187

13:30 Michael Stumpf (The University of Melbourne)
The origins of heavy-tailed laws in biology (p. 105)

14:20 timothy hewson (University of Tasmania)
Graded rings of Markov invariants (p. 103)

14:45 Julia Shore (University of Tasmania)
The ancient Operational Code is embedded in the amino acid substitution matrix and aaRS phylogenies (p. 105)

15:35 Venta Terauds (University of Tasmania)
Symmetry and redundancy: choosing the right algebra for circular genome distance computations (p. 105)

16:00 Jeremy Sumner (University of Tasmania)
The Markov embedding problem from an algebraic perspective (p. 105)

16:25 Chad Mathew Clark (Western Sydney University)
An Algebraic Inversion-Deletion Model for Bacterial Genome Rearrangement (p. 103)

16:50 Joshua Stevenson (University of Tasmania)
Investigating rank-based approaches for inferring phylogenies (p. 105)

17:15 Adarsh Kumbhari (The University of Sydney)
Emergent signal processing in T cells via regulatory immune mechanisms (p. 104)

17:40 Pantea Pooladvand (The University of Sydney)
Modelling the Immune Response of CD4+ T cells: An intimate relationship between T cells and APCs (p. 104)

15. Mathematics Education

G60

13:30 Poh Hillock (The University of Queensland)
Blended learning in a large first year mathematics course (p. 107)

13:55 Simon James (Deakin University)
Peer assessment and feedback - in class and online (p. 108)

14:20 Jennifer Palisse (The University of Melbourne)
Can Comparative Judgement Improve Student Performance with Rational Inequalities? (p. 108)

14:45 Joshua Capel (UNSW Sydney)
Learning and Teaching in a Digital world (p. 107)

16:00 Jelena Schmalz (University of New England)
Mathematics Enrichment Program at UNE – from Primary School to University (p. 109)

16:25 Renu Choudhary (Auckland University of Technology)

Empowering, Engaging and Enhancing Students' Learning using a Pen-Enabled Tablet (p. 107)

16:50 Diane Donovan (The University of Queensland)
Should I apply for a Teaching Award (p. 107)

16. Mathematical Physics, Statistical Mechanics and Integrable systems

G55

13:30 Tony Guttmann (The University of Melbourne)
Some recent developments in self-avoiding walks (p. 111)

13:55 Abrahim Steve Nasrawi (Monash University)
The length of self-avoiding walks on the complete graph (p. 112)

14:20 Seamus Albion (The University of Queensland)
Selberg integrals and the AGT conjecture (p. 110)

14:45 Katherine Anne Seaton (La Trobe University)
Rolling, rolling, rolling (p. 113)

15:35 Anas Abdur Rahman (The University of Melbourne)
Recursions on the Moments of Random Matrix Ensembles (p. 112)

16:00 Allan Trinh (The University of Melbourne)
Finite size corrections at the hard edge for the Laguerre β ensemble (p. 113)

16:25 Jiyuan Zhang (The University of Melbourne)
Spherical transform and randomised Horn problem (p. 113)

16:50 Peter Forrester (The University of Melbourne)
Further random matrix fermi gas analogies (p. 110)

17:15 Mario Kieburg (The University of Melbourne)
Matrix products involving Hermitian Random Matrices (p. 111)

17:40 Jesper Ipsen (The University of Melbourne)
Large complex systems beyond the instability threshold (p. 111)

17. Number Theory and Algebraic Geometry

G57

13:30 Peng Gao (Beihang University)
Lower order terms for the one level density of quadratic Hecke L-functions in the Gaussian field (p. 115)

14:20 Benjamin Moore (The University of Adelaide)
Quartic Gauss sums and twisted reciprocity (p. 116)

14:45 Kam Hung Yau (University of New South Wales)
A relaxation of Goldbach's conjecture (p. 117)

15:35 Michaela Cully-Hugill (University of New South Wales Canberra)
Explicit results on the sum of a divisor function (p. 115)

16:00 Shehzad Shabbirbhai Hathi (UNSW Canberra)
Biases, oscillations, and first sign changes in arithmetic functions (p. 116)

16:25 Ayreena Bakhtawar (La Trobe University)
Improvements to Dirichlet's theorem in Diophantine approximation (p. 115)

19. Probability Theory and Stochastic Processes

183

13:30 Dareen Omari (La Trobe University)
Non-central asymptotics for functionals of strong-weak dependent vector random fields (p. 125)

13:55 Zdravko Botev (University of New South Wales)
Novel Methods for Model Selection in Linear Regression (p. 122)

14:20 Libo Li (University of New South Wales)
Positivity Preserving Numerical Schemes for Jump-extended CIR/CEV Process (p. 124)

14:45 Kais Hamza (Monash University)
Matching marginals and sums (p. 123)

15:35 Jie Yen Fan (Monash University)
Local Brownian Motions (p. 122)

16:00 Kevin Lu (Australian National University)
Multivariate Lévy-driven Ornstein-Uhlenbeck processes Using Weak Subordination (p. 124)

16:25 Laurence Field (Australian National University)
Brownian motion in multiply connected planar domains (p. 123)

16:50 Illia Donhauzer (La Trobe University)
On some asymptotics of functionals of long-range dependent random fields. (p. 122)

17:15 Tareq Alodat (La Trobe University)
Limit theorems for filtered long-range dependent random fields (p. 122)

20. Representation Theory

G62

13:30 Anna Romanov (The University of Sydney)
Contravariant forms on Whittaker modules (p. 128)

13:55 Kevin Coulembier (The University of Sydney)
Classification of blocks in category O (p. 127)

14:20 David Ridout (The University of Melbourne)
Representations of affine vertex algebras: beyond category $\mathcal{O}$ (p. 127)

14:45 Zachary Fehily (The University of Melbourne)
Classification of relaxed highest-weight modules for admissible level Bershadsky-Polyakov algebras (p. 127)

15:35 Masoud Kamgarpour (University of Queensland)
Geometric Langlands for Wild Hypergeometric Sheaves (p. 127)

16:00 Kari Vilonen (The University of Melbourne)
Real Groups, Hodge Theory, and the Langlands duality (p. 128)

16:50 Linyuan Liu (The University of Sydney)
Cohomology of line bundles on flag varieties (p. 127)

17:15 Yusra Naqvi (The University of Sydney)
A gallery model for affine flag varieties (p. 127)

17:40 Travis Scrimshaw (The University of Queensland)
Crystal structures for canonical Grothendieck functions (p. 128)

21. Topology

137

13:30 Daniel Mathews (Monash University)
Geometry and physics of circle packings (p. 130)

13:55 Anupam Chaudhuri (Monash University)
Local topological recursion governs the enumeration of lattice points in $\overline{\mathcal{M}}_{g,n}$ (p. 129)

14:20 Mehdi Tavakol (The University of Melbourne)
Tautological classes with twisted coefficients (p. 131)

14:45 Ellena Moskovsky (Monash University)
On the topological recursion for double Hurwitz numbers (p. 130)

15:35 Csaba Nagy (The University of Melbourne)
The Sullivan-conjecture in complex dimension 4 (p. 131)

16:00 Grace Garden (The University of Sydney)
The Mapping Class Group Action on the Character Variety of the Once-Punctured Torus (p. 129)

16:25 Michael Swaddle (AMSI/University of Melbourne)
Airy structures and topological recursion (p. 131)

16:50 Guo Chuan Thiang (The University of Adelaide)
T-dualities of orbifolds (p. 132)

17:15 Wee chaimanowong (AMSI/University of Melbourne)
Deformation of Curves and Topological Recursions (p. 129)

17:40 Norman Do (Monash University)
On the Goulden–Jackson–Vakil conjecture for double Hurwitz numbers (p. 129)

Thu 5 December 2019

▪ Summary timetable

When	What	Where
09:00–10:00	**Plenary:** Ulcigrai	G81
10:00–10:30	Morning tea	
10:30–11:30	**Plenary:** Steinberg	G81
11:30–12:30	**Plenary:** Trudgian	G81
12:30–13:30	Lunch	
13:30–13:55	11 special session talks	Various locations (see below)
13:55–14:20	11 special session talks	Various locations (see below)
14:20–14:45	10 special session talks	Various locations (see below)
14:45–15:10	Afternoon Tea	
15:10–16:00	**Plenary:** Rylands	G81
16:00–17:15	AGM	G81

▪ Special Sessions

2. Algebra

G58

13:30 Amnon Neeman (Australian National University)
Non Fourier-Mukai functors (p. 67)

13:55 Robert McDougall (University of the Sunshine Coast)
Interpreting a radical theory identity for classes of associative rings (p. 66)

14:20 Abdullahi Umar (Khalifa University of Science, Technology)
Some Remarks on monoids of contraction mappings of a finite chain (p. 68)

5. Combinatorics and Graph Theory

G56

13:30 Amin Sakzad (Monash University)
Middle Product Learning With Errors (p. 77)

13:55 Lynn Batten (Deakin University)
How generic ring algorithms and labelled binary trees helped solve an outstanding factoring problem in number theory. (p. 73)

14:20 Andrea Burgess (University of New Brunswick)
The firebreak problem (p. 73)

6. Computational Mathematics

189

13:30 Thanh Tran (University of New South Wales)
A posteriori error estimation for nonlinear elliptic equations (p. 82)

13:55 Jerome Droniou (Monash University)
High-order numerical schemes for degenerate elliptic equations (p. 79)

14:20 Quoc Thong Le Gia (University of New South Wales)
A multiscale radial basis function method for severely ill-posed problems on spheres (p. 80)

7. Dynamical Systems and Ergodic Theory

123

13:30 Kenneth James Palmer (National Taiwan University)
On Sil'nikov saddle-focus homoclinic orbits (p. 84)

13:55 Davide Ravotti (Monash University)
A geometric proof of Ratner's mixing rates for the horocycle flow (p. 85)

14:20 Sean Gasiorek (The University of Sydney)
On the Dynamics of Inverse Magnetic Billiards (p. 83)

8. Financial mathematics

182

13:30 Libo Li (University of New South Wales)
Mean-field stable CIR process (p. 86)

13:55 Anna Aksamit (The University of Sydney)
Modelling additional information: filtration enlarged via a marked random time (p. 86)

14:20 Zhou Zhou (The University of Sydney)
On the Notions of Equilibria for Time-inconsistent Stopping Problems in Continuous Time (p. 87)

11. Geometry including Differential Geometry

183

13:30 Benjamin Blake McMillan (The University of Adelaide)
Conservation laws and parabolic Monge-Ampere equations (p. 95)

13:55 A. Rod Gover (The University of Auckland)
Distinguished curves and integrability in Riemannian and conformal geometry (p. 95)

12. Harmonic and Semiclassical Analysis

134

13:30 Lesley Ward (University of South Australia)
Product Hardy space theory on spaces of homogeneous type via orthonormal wavelet bases (p. 99)

13:55 Adam Sikora (Macquarie University)
Spectral multipliers without semigroup framework and application to random walks (p. 99)

14:20 Ji Li (Macquarie University)
Commutators of Cauchy-Szego type integrals for domains in C^n with minimal smoothness (p. 98)

14. Mathematical Biology

187

13:30 Sukhen Das (Jadavpur University)
Study of HIV in-host model through multi-pathways infection under different blockers : local and global analysis (p. 103)

13:55 Nandadulal Nandadulal Bairagi (Jadavpur University)
Pattern formation in a reaction-diffusion predator-prey-parasite model with prey infection under the influence of ecological and epidemiological parameters (p. 104)

14:20 Dipak Kumar Kesh (Jadavpur University)
Role of induced plant volatile and refuge in tritrophic model (p. 104)

16. Mathematical Physics, Statistical Mechanics and Integrable systems

G55

13:30 Dinh Tran (The University of Sydney)
Hierarchies of q-discrete second, third and fourth Painlevé equations and their properties (p. 113)

13:55 Nalini Joshi (The University of Sydney)
Painlev'e VI in Okamoto's Space (p. 111)

14:20 Pieter Roffelsen (International School for Advanced Studies (SISSA))
On the asymptotic distribution of roots of the generalised Hermite polynomials (p. 113)

17. Number Theory and Algebraic Geometry

G57

13:30 James Borger (Australian National University)
The etale fundamental group of semirings (p. 115)

13:55 Thomas Morrill (UNSW Canberra)
A combinatoric proof of Jackson's summation (p. 116)

14:20 Chenyan Wu (The University of Melbourne)
Involutive property and irreducibility of theta correspondence (p. 117)

18. Optimisation

188

13:30 Nadia Sukhorukova (Swinburne University of Technology)
Remez method applicability in Chebyshev approximation problems (p. 121)

13:55 James Saunderson (Monash University)
Certifying polynomial nonnegativity via hyperbolic optimisation (p. 120)

14:20 Scott Boivin Lindstrom (Hong Kong Polytechnic University)
On the Projected Polar Proximal Point Algorithm (p. 119)

Fri 6 December 2019

▪ Summary timetable

When	What	Where
09:00–10:00	**Plenary:** Giga	G81
10:00–10:30	Morning tea	
10:30–11:30	**Plenary:** Norbury	G81
11:30–12:30	**Plenary:** Samotij	G81
12:30–13:30	Lunch	
13:30–13:55	11 special session talks	Various locations (see below)
13:55–14:20	10 special session talks	Various locations (see below)
14:20–14:45	10 special session talks	Various locations (see below)
14:45–15:10	Afternoon Tea	
15:10–15:35	9 special session talks	Various locations (see below)
15:35–16:00	9 special session talks	Various locations (see below)
16:00–16:25	5 special session talks	Various locations (see below)
16:25–16:50	2 special session talks	Various locations (see below)

▪ Special Sessions

2. Algebra

G58

13:30 James East (Western Sydney University)
Presentations for diagram algebras and categories (p. 65)

13:55 Richard Garner (Macquarie University)
Generalising the étale groupoid–complete pseudogroup correspondence (p. 65)

14:20 Tim Stokes (University of Waikato)
Demonic composition and inverse semigroups. (p. 68)

15:10 Tomasz Kowalski (La Trobe University)
A little beyond wreath and block (p. 66)

15:35 Thomas Quella (The University of Melbourne)
Takiff superalgebras and conformal field theory (p. 67)

16:00 Marcel Jackson (La Trobe University)
Algebras defined by equations (p. 66)

5. Combinatorics and Graph Theory

G56

13:30 Sanming Zhou (The University of Melbourne)
The vertex-isoperimetric number of the incidence graphs of unitals and finite projective spaces (p. 78)

13:55 Greg Markowsky (Monash University)
The Cheeger constant for distance-regular graphs. (p. 77)

14:20 Binzhou Xia (The University of Melbourne)
Some examples of nonnormal Cayley graphs on nonabelian simple groups (p. 78)

15:10 Joanne Hall (Royal Melbourne Institute of Technology)
Constructions of Difference Covering Arrays using Skolem sequences (p. 75)

15:35 Vesa Kaarnioja (University of New South Wales)
An improved lower bound on Hong and Loewy's numbers (p. 76)

16:00 Son Hoang Dau (RMIT University)
MaxMinSum Steiner Systems for Access-Balancing in Distributed Storage (p. 74)

16:25 Kevin Hendrey (Institute for Basic Science)
Covering radius in the Hamming permutation space (p. 75)

9. Functional Analysis, Operator Algebra, Non-commutative Geometry

134

13:30 Hendra Gunawan (Bandung Institute of Technology)
Some geometric constants for Morrey spaces (p. 89)

13:55 Roozbeh Hazrat (Western Sydney University)
The talented monoid of a directed graph (p. 89)

14:20 Geetika Verma (University of South Australia)
Inversion of operator pencils on Banach space using Jordan chains (p. 89)

10. Geometric Analysis and Partial Differential Equations

136

13:30 Enrico Valdinoci (The University of Western Australia)
Nonlocal minimal graphs in the plane are generically sticky (p. 94)

13:55 Zihua Guo (Monash University)
Ill-posedness of the Camassa-Holm and related equations in the critical space (p. 92)

14:20 Matthew Kevin Cooper (University of New England)
Symmetric biharmonic maps (p. 91)

15:10 Kwok-Kun Kwong (University of Wollongong)
Quantitative comparison theorems in geometry (p. 92)

15:35 Sevvandi Priyanvada Kandanaarachchi (Monash University)
Singularities of Axially Symmetric Volume Preserving Mean Curvature Flow (p. 92)

11. Geometry including Differential Geometry

186

13:30 Yuri Nikolayevsky (La Trobe University)
On cylindricity of submanifolds of nonnegative Ricci curvature in a Minkowski space (p. 96)

13:55 Andreas Vollmer (University of New South Wales)
Second order superintegrable systems in arbitrary dimension (p. 97)

14:20 Krzysztof Krakowski (Cardinal Stefan Wyszynski University in Warsaw)
Rolling Symmetric Spaces (p. 95)

15:10 Marcos Origlia (Monash University)
Locally conformal Käler or symplectic structures on compact solvmanifolds (p. 96)

15:35 Owen Dearricott (The University of Melbourne)
Positive curvature in dimension seven (p. 95)

14. Mathematical Biology

187

13:30 Andrew Francis (Western Sydney University)
The space of tree-based phylogenetic networks (p. 103)

13:55 Lucy Ham (The University of Melbourne)
Extrinsic noise and heavy-tailed distributions in gene expression (p. 103)

15. Mathematics Education

G60

13:30 Jennifer Palisse (The University of Melbourne)
Making the Grade: Do Mathematics Marks Matter to Women in STEM (p. 108)

13:55 Jonathan Kress (University of New South Wales)
Assessment in First Year Mathematics (p. 108)

14:20 Donald Shearman (Western Sydney University)
Does the Effectiveness of Mathematics and Statistics Support Depend on Students' Mathematical Background? (p. 109)

15:10 Deborah Jackson (La Trobe University)
Igniting interest, inspiration, investigation and intrigue within mathematics support. (p. 107)

15:35 Terence Mills (La Trobe University)
Can Kuhn revolutionise mathematics teaching? (p. 108)

16. Mathematical Physics, Statistical Mechanics and Integrable systems

G55

13:30 Margaret Reid (Swinburne University of Technology)
Quantum Entanglement, Schrodinger's cat, and the Q-function phase-space model of reality (p. 112)

13:55 Thomas Quella (The University of Melbourne)
Conformal field theory and the non-abelian SU(2) level k chiral spin liquid (p. 112)

14:20 Alexandr Garbali (The University of Melbourne)
A lattice model with the symmetry of the quantum toroidal gl_1 algebra (p. 110)

15:10 Laurence Field (Australian National University)
Escape estimates for SLE (p. 110)

15:35 Timothy Garoni (Monash University)
Critical speeding up in dynamical percolation (p. 110)

16:00 Zongzheng Zhou (Monash University)
The coupling time of the Ising Glauber dynamics (p. 114)

18. Optimisation

188

13:30 Alexander Ioffe (Technion, Israel Institute of Technology)
On the strong minimum in optimal control. A view from variational analysis. (p. 119)

14:20 Vladimir Gaitsgory (Macquarie University)
Linear Programming Based Optimality Conditions for Long Run Average Optimal Control Problems (p. 118)

15:10 Andrew Craig Eberhard (RMIT University)
A Progressive Hedging - Feasibility Pump for Stochastic Integer Programming (p. 118)

15:35 Janosch Rieger (Monash University)
A linear programming approach to approximating the infinite time reachable set of strictly stable linear control systems (p. 120)

16:00 Julien Ugon (Deakin University)
Best chebyshev approximation by rational functions (p. 121)

16:25 Vera Roshchina (UNSW Sydney)
Optimal selling mechanism design in the presence of budget constraints (p. 120)

19. Probability Theory and Stochastic Processes

183

13:30 Peter Taylor (The University of Melbourne)
A model for cell proliferation in a developing organism (p. 125)

13:55 Fima Klebaner (Monash University)
Effect of small noise leading to random initial conditions in dynamical systems (p. 123)

14:20 Andriy Olenko (La Trobe University)
Stochastic hyperbolic diffusion equations on the sphere (p. 125)

15:10 Hermanus Marinus Jansen (The University of Queensland)
The asymptotic behaviour of the time-varying supermarket model (p. 123)

15:35 Nigel Bean (The University of Adelaide)
Yaglom Limit for Stochastic Fluid Models (p. 122)

21. Topology

137

13:30 Marcy Robertson (The University of Melbourne)
Modelling homology operations in string topology (p. 131)

13:55 Martin Helmer (Australian National University)
Complex Linking Numbers for Strata of Varieties (p. 130)

14:20 TriThang Tran (The University of Melbourne)
Braids and shuffle algebras (p. 132)

15:10 Xing Gu (AMSI/University of Melbourne)
The topological period-index problem (p. 129)

15:35 David Roberts (The University of Adelaide)
A descent-theoretic proof of a theorem of Serre (p. 131)

16:00 Paul Norbury (The University of Melbourne)
Polynomial relations among kappa classes on the moduli space of curves (p. 131)

List of Registrants

Current as of Fri 22 Nov 2019

Dr Ciprian Sorin Acatrinei	National Institute for Nuclear Physics and Engineering
Ms Riya Aggarwal	(S) The University of Newcastle
Dr Anna Aksamit	The University of Sydney
Mrs Shaymaa Shawkat Al-shakarchi	(S) University of New South Wales
Mr Seamus Albion	(S) The University of Queensland
Dr Amie Albrecht	University of South Australia
Mr Samuel Bruce Allan	(S) University of the Sunshine Coast
Mr Tareq Alodat	(S) La Trobe University
Dr Alex Amenta	University of Bonn
Prof Astrid an Huef	Victoria University of Wellington
Dr Andrii Arman	Monash University
Dr Romina Melisa Arroyo	University of Queensland
Dr Jason Atnip	University of New South Wales
Mr Hamed Baghal Ghaffari	(S) The University of Newcastle
Miss Ayreena Bakhtawar	(S) La Trobe University
Assoc Prof Rowena Ball	The Australian National University
Dr Santiago Barrera Acevedo	Monash University
Dr Loretta Bartolini	Springer-Verlag
Mr Fawwaz Batayneh	(S) University of Queensland
Prof Lynn Batten	Deakin University
Prof Nigel Bean	The University of Adelaide
Dr Nicholas Beaton	The University of Melbourne
Prof Jon Berrick	The University of Sydney
Mr Abhishek Bhardwaj	(S) Australian National University
Dr Burzin Bhavnagri	Monash University
Mr Matteo Bordignon	(S) University of New South Wales Canberra
Dr James Borger	Australian National University
Dr Zdravko Botev	University of New South Wales
Ms Elizabeth Bradford	(S) University of South Australia
Dr Richard Brak	The University of Melbourne
Mr Jack Brand	(S) Australian Mathematical Sciences Institute
Prof Philip Broadbridge	La Trobe University
Mr David Leonard Brook	(S) The University of Adelaide
Mr Paul Bryan	Macquarie University
Dr Valentin Buciumas	The University of Queensland
Dr Pascal R Buenzli	Queensland University of Technology
Ms Thi Hoa Bui	(S) Federation University Australia
Mr Yudhistira Andersen Bunjamin	(S) UNSW Sydney
Dr Andrea Burgess	University of New Brunswick
Prof Benjamin Burton	University of Queensland
Dr Joshua Capel	UNSW Sydney
Dr Nicholas Cavenagh	University of Waikato
Mr Wee chaimanowong	(S) AMSI/University of Melbourne
Miss Su Yuan Chan	(S) Deakin University
Miss Ting-Ying Chang	(S) University of New England
Mr Anupam Chaudhuri	(S) Monash University
Dr Renu Choudhary	Auckland University of Technology
Assoc Prof Florica Corina Cirstea	The University of Sydney
Mr Chad Mathew Clark	(S) Western Sydney University

Mr Bryce Clarke	(S) Macquarie University
Mr Michael Clarke	(S) UNSW Sydney
Dr Nathan Clisby	Swinburne University of Technology
Dr Julie Clutterbuck	Monash University
Dr Andrea Collevecchio	Monash University
Dr Julia Collins	Edith Cowan University
Dr Michael Coons	The University of Newcastle
Dr Matthew Kevin Cooper	University of New England
Dr Kevin Coulembier	The University of Sydney
Don Coutts	Canberra Institute of Technology
Mr William Crawford	(S) Monash University
Dr Anthony Cronin	University College Dublin
Mx Diarmuid Crowley	The University of Melbourne
Ms Michaela Cully-Hugill	(S) University of New South Wales Canberra
Mr Kaustav Das	(S) Monash University
Prof Sukhen Das	Jadavpur University
Dr Son Hoang Dau	RMIT University
Prof Jan De Gier	The University of Melbourne
Ms Ajani De Vas Gunasekara	(S) Monash University
Dr Owen Dearricott	The University of Melbourne / La Trobe University
Dr H. Kumudini Dharmadasa	University of Tasmania
Dr Heiko Dietrich	Monash University
Assoc Prof Serena Dipierro	The University of Western Australia
Mr Neil Kristofer Dizon	(S) The University of Newcastle
Dr Norman Do	Monash University
Mr Illia Donhauzer	(S) La Trobe University
Prof Diane Donovan	The University of Queensland
Dr James Dowty	The University of Melbourne
Assoc Prof Jerome Droniou	Monash University
Prof Xuan Duong	Macquarie University
Dr James East	Western Sydney University
Prof Andrew Craig Eberhard	RMIT University
Dr Vladimir Ejov	Flinders University
Mr Patrick Elliott	(S) The University of Melbourne
Prof Andreas Ernst	Monash University
Ms Jie Yen Fan	Monash University
Dr Maria Farcaseanu	The University of Sydney
Prof Graham Farr	Monash University
Zachary Fehily	(S) The University of Melbourne
Dr Michal Ferov	The University of Newcastle
Prof Lilia Ferrario	Australian National University
Mr Nicholas Fewster-Young	University of South Australia
Dr Laurence Field	Australian National University
Dr Guillermo Javier Flores	Universidad Nacional de Cordoba
Dr Chi-Kwong Fok	The University of Auckland
Prof Peter Forrester	The University of Melbourne
Prof Andrew Francis	Western Sydney University
Mr Forrest James Francis	(S) Australian Defence Force Academy
Assoc Prof Federico Frascoli	Swinburne University of Technology
Mr Matthias Fresacher	(S) University of Adelaide
Prof Gary Froyland	University of New South Wales
Prof Vladimir Gaitsgory	Macquarie University
Assoc Prof Linda Galligan	University of Southern Queensland
Dr Han Gan	Northwestern University
Prof Peng Gao	Beihang University
Dr Alexandr Garbali	The University of Melbourne
Ms Grace Garden	(S) The University of Sydney
Dr Richard Garner	Macquarie University
Assoc Prof Timothy Garoni	Monash University

Dr Alejandra Garrido	The University of Newcastle
Dr Sean Gasiorek	The University of Sydney
Dr Jesse Gell-Redman	AMSI/University of Melbourne
Dr Alexandru Ghitza	The University of Melbourne
Dr Mi-Ho Giga	University of Tokyo
Prof Yoshikazu Giga	University of Tokyo
Mr Michael James Gill	(S) Monash University
Dr Cecilia Gonzalez-Tokman	The University of Queensland
Prof A. Rod Gover	The University of Auckland
Mr Adam Gowty	(S) Monash University
Mrs Charles Gray	(S) La Trobe University
Prof Robert Charles Griffiths	Monash University
Dr Jens Grimm	(S) Monash University
Prof Joseph Grotowski	The University of Queensland
Dr Xing Gu	AMSI/University of Melbourne
Prof Hendra Gunawan	Bandung Institute of Technology
Dr Hailong Guo	The University of Melbourne
Dr Ivan Guo	Monash University
Mr Zihua Guo	Monash University
Prof Tony Guttmann	The University of Melbourne
Prof Christian Haesemeyer	The University of Melbourne
Ms Anna Haley	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) Monash University
Assoc Prof Kais Hamza	Monash University
Dr Dylan Harries	CSIRO
Assoc Prof David Harvey	University of New South Wales
Prof Andrew Hassell	Australian National University
Mr Shehzad Shabbirbhai Hathi	(S) UNSW Canberra
Dr Daniel Hauer	The University of Sydney
Mx Eli Hazel	(S) Macquarie University
Prof Roozbeh Hazrat	Western Sydney University
Prof Markus Hegland	Australian National University
Dr Martin Helmer	Australian National University
Dr Kevin Hendrey	Institute for Basic Science
Mr Edmund Xian Chen Heng	(S) Australian National University
Prof Bruce Henry	University of New South Wales
Prof Hai-Long Her	The Australian National University
Mr timothy hewson	(S) University of Tasmania
Dr Poh Hillock	The University of Queensland
Dr Craig Hodgson	The University of Melbourne
Assoc Prof Mark Holmes	The University of Melbourne
Dr Daniel Horsley	Monash University
Seyed Soheil Hosseini	(S) Monash University
Dr Algy Howe	Australian National University
Dr Mumtaz Hussain	La Trobe University
Prof Alexander Ioffe	Technion, Israel Institute of Technology
Dr Jesper Ipsen	The University of Melbourne
Dr Deborah Jackson	La Trobe University
Dr Marcel Jackson	La Trobe University
Dr Simon James	Deakin University
Mr Hermanus Marinus Jansen	The University of Queensland
Mr Divahar Jayaraman	(S) The University of Adelaide
Mr Sam Jelbart	(S) The University of Sydney
Mrs Sangeeta Jhanjee	(S) Monash University
Mr Benjamin Jones	(S) Monash University

Prof Nalini Joshi	The University of Sydney
Dr Vesa Kaarnioja	University of New South Wales
Dr Nina Kamcev	Monash University
Dr Masoud Kamgarpour	University of Queensland
Dr Sevvandi Priyanvada Kandanaarachchi	Monash University
Mr Parsa Kavkani	(S) The University of Adelaide
Prof Dipak Kumar Kesh	Jadavpur University
Dr Mario Kieburg	The University of Melbourne
Mr Edward Kim	(S) The University of Sydney
Assoc Prof Deborah King	The University of Melbourne
Dr Vassili Kitsios	CSIRO
Prof Fima Klebaner	Monash University
Prof Sung-Eun Koh	Konkuk Univ.
Mr James Mathew Koussas	(S) La Trobe University
Dr Tomasz Kowalski	La Trobe University
Dr Krzysztof Krakowski	Cardinal Stefan Wyszynski University in Warsaw
Assoc Prof Jonathan Kress	University of New South Wales
Dr Holly Krieger	University of Cambridge
Prof Alexander Kruger	Federation University Australia
Mr Oliver krzysik	(S) Monash University
Mr Adarsh Kumbhari	(S) The University of Sydney
Dr Kwok-Kun Kwong	University of Wollongong
Dr Ramiro Augusto Lafuente	The University of Queensland
Dr Quoc Thong Le Gia	University of New South Wales
Mr Ethan Simpson Lee	(S) UNSW Canberra
Dr Galina Levitina	University of New South Wales
Mr Angus Hamilton Lewis	(S) The University of Adelaide
Dr Ji Li	Macquarie University
Libo Li	University of New South Wales
Mr Kevin Limanta	(S) University of New South Wales
Dr Scott Boivin Lindstrom	Hong Kong Polytechnic University
Dr Boris Lishak	The University of Sydney
Dr Linyuan Liu	The University of Sydney
Dr Heather Lonsdale	Curtin University
Prof Ryan Loxton	Curtin University
Kevin Lu	Australian National University
Dr Fu Ken Ly	The University of Sydney
Mr Michael Lydeamore	(S) Monash University
Mr Sean Lynch	(S) UNSW Sydney
Stephen Lynch	(S) University of Tubingen
Mr Yilin Ma	(S) The University of Sydney
Mr Matthew Mack	Multiple Universities
Dr Barbara Maenhaut	The University of Queensland
Mr Kelly Maggs	(S) The Australian National University
Mr Adam Mammoliti	Monash University
Dr Gianmarco Manzini	Consiglio Nazionale delle Ricerche (CNR) - Italy
Dr Greg Markowsky	Monash University
Dr Daniel Mathews	Monash University
Dr Nick McConnell	Defence Science and Technology Group
Dr Robert McDougall	University of the Sunshine Coast
Prof Mark Joseph McGuinness	Victoria University of Wellington
Dr Benjamin Blake McMillan	The University of Adelaide
Dr Joel Miller	La Trobe University
Prof Terence Mills	La Trobe University
Dr Asghar Moeini	(S) Curtin University
Mr Benjamin Moore	(S) The University of Adelaide
Prof Primoz Moravec	University of Ljubljana
Dr Thomas Morrill	UNSW Canberra
Prof Sid Morris	Federation University Australia

Miss Ellena Moskovsky	(S) Monash University
Mr Csaba Nagy	(S) The University of Melbourne
Dr Kihun Nam	Monash University
Prof Nandadulal Nandadulal Bairagi	Jadavpur University
Prof Nandadulal Nandadulal Bairagi	University of Calcutta
Dr Yusra Naqvi	The University of Sydney
Prof Makoto Narita	National Institute of Technology, Okinawa College
Mr Abrahim Steve Nasrawi	(S) Monash University
Prof Amnon Neeman	Australian National University
Dr Giang Nguyen	The University of Adelaide
Dr Minh Nguyen	Monash University
Ms Trang Thi Thien Nguyen	(S) University of South Australia
Mr Cuong Nguyen Duy	(S) Federation University Australia
Mr adam nie	(S) Australian National University
Dr Yuri Nikolayevsky	La Trobe University
Miss WEI Ning	(S) Monash University
Prof Paul Norbury	The University of Melbourne
Mr Jeremy Nugent	(S) University of New South Wales
Dr Terry O'Kane	CSIRO
Dr Greg Oates	University of Tasmania
Prof Jan Obloj	University of Oxford
Mr Peter Olanipekun	(S) Monash University
Dr Andriy Olenko	La Trobe University
Dr Todd Oliynyk	Monash University
Mrs Dareen Omari	(S) La Trobe University
Jordan Orchard	(S) Swinburne University of Technology
Dr Marcos Origlia	Monash University
Dr John Ormerod	The University of Sydney
Mr Kieran Emmett OĹoughlin	(S) The University of Adelaide
Mx Jennifer Palisse	(S) The University of Melbourne
Prof Kenneth James Palmer	National Taiwan University
Ms Xueyu Pan	(S) Monash University
Dr Brett Parker	Monash University
Dr Bregje Pauwels	The University of Sydney
Dr Michael Payne	La Trobe University
Dr Collin Grant Phillips	The University of Sydney
Dr Guillermo Pineda-Villavicencio	Deakin University
Mx João Vitor Pinto e Silva	(S) The University of Newcastle
Ms Pantea Pooladvand	(S) The University of Sydney
Prof Geoffrey Prince	La Trobe University
Dr Artem Pulemotov	The University of Queensland
Prof Jessica Purcell	Monash University
Dr Thomas Quella	The University of Melbourne
Dr El Houssaine QUENJEL	Nice Sophia Antipolis University
Dr Courtney Rose Quinn	CSIRO
Mr Anas Abdur Rahman	(S) The University of Melbourne
Mrs Samithree Rajapaksha	(S) Monash University
Prof Jacqui Ramagge	The University of Sydney
Prof Alejandro Francisco Ramirez	Catholic University of Chile
Mr Zhenlin Ran	(S) The University of Newcastle
Prof Asha Rao	Royal Melbourne Institute of Technology
Dr Davide Ravotti	Monash University
Dr Colin David Reid	The University of Newcastle
Prof Margaret Reid	Swinburne University of Technology
Dr David Ridout	The University of Melbourne
Dr Janosch Rieger	Monash University
Dr David Roberts	The University of Adelaide
Dr Marcy Robertson	The University of Melbourne
Mr Christopher P Rock	(S) UNSW Sydney

Dr Chris Roe	Retired
Miss Elisabeth Roesch	(S) The University of Melbourne
Mr Pieter Roffelsen	International School for Advanced Studies (SISSA)
Dr Anna Romanov	The University of Sydney
Dr Vera Roshchina	UNSW Sydney
Martina Rovelli	The Australian National University
Assoc Prof Leanne Rylands	Western Sydney University
Mr Subhrajyoti Saha	(S) Monash University
Dr Amin Sakzad	Monash University
Assoc Prof Wojciech Samotij	Tel Aviv University
Dr Alba Santin Garcia	The University of Melbourne
Dr James Saunderson	Monash University
Dr Jeroen Schillewaert	University of Auckland
Dr Volker Schlue	The University of Melbourne
Prof Gerd Schmalz	University of New England
Dr Jelena Schmalz	University of New England
Dr Travis Scrimshaw	The University of Queensland
Dr Katherine Anne Seaton	La Trobe University
Dr Nir sharon	Tel Aviv University
Mr Donald Shearman	Western Sydney University
Ms Wenhui Shi	Monash University
Mrs Julia Shore	(S) University of Tasmania
Prof Harvinder Sidhu	University of New South Wales
Dr Leesa Sidhu	University of New South Wales Canberra
Dr Adam Sikora	Macquarie University
Dr Joanna Sikora	Australian National University
Mr Aleksander Simonic	(S) University of New South Wales Canberra
Dr Anoop Sivasankaran	Khalifa University of Science, Technology
Dr Lachlan Smith	The University of Sydney
Mr Angus Southwell	(S) Monash University
Dr Belinda Spratt	Queensland University of Technology
Dr Peter Stacey	La Trobe University
Dr Benjamin Steinberg	City University of New York
Mr Joshua Stevenson	(S) University of Tasmania
Dr Tim Stokes	University of Waikato
Ms Michelle Strumila	(S) The University of Melbourne
Prof Michael Stumpf	The University of Melbourne
Dr Nadia Sukhorukova	Swinburne University of Technology
Dr Jeremy Sumner	University of Tasmania
Prof Jie Sun	Curtin University
Mr Léon Surel	(S) The University of Sydney
Michael Swaddle	(S) AMSI/University of Melbourne
Mr Srinibas Swain	(S) Monash University
Dr Thomas Taimre	University of Queensland
Dr Mehdi Tavakol	The University of Melbourne
Prof Peter Taylor	The University of Melbourne
Mr Stuart Teisseire	(S) The University of Adelaide
Mr Giacomo Tendas	(S) Macquarie University
Dr Venta Terauds	University of Tasmania
Dr Guo Chuan Thiang	The University of Adelaide
Assoc Prof Anne Thomas	The University of Sydney
Dr Bevan Thompson	The University of Queensland
Miss Lauren Thornton	(S) University of the Sunshine Coast
Dr Dinh Tran	The University of Sydney
Assoc Prof Thanh Tran	University of New South Wales
Dr TriThang Tran	The University of Melbourne
Mr Allan Trinh	(S) The University of Melbourne
Dr Timothy Trudgian	UNSW Canberra
Dr Ilknur Tulunay	UNSW Sydney

Dr Julien Ugon	Deakin University
Prof Corinna Ulcigrai	University of Zurich
Dr Abdullahi Umar	Khalifa University of Science, Technology
Prof Enrico Valdinoci	The University of Western Australia
Ms Shibani Veeraragavan	(S) Monash University
Paula Verdugo	(S) Macquarie University
Dr Geetika Verma	University of South Australia
Prof Kari Vilonen	The University of Melbourne
Dr Andreas Vollmer	University of New South Wales
Shiyi Wang	(S) Monash University
Prof Ian Wanless	Monash University
Assoc Prof Lesley Ward	University of South Australia
Prof Ole Warnaar	The University of Queensland
Dr Yong Wei	Australian National University
Dr Valentina-Mira Wheeler	University of Wollongong
Dr Aaron Wiegand	University of the Sunshine Coast
Dr Tim Wilson	Monash University
Prof David Wood	Monash University
Dr Nicholas Wormald	Monash University
Dr Chenyan Wu	The University of Melbourne
Ms Yuhan Wu	(S) University of Wollongong
Dr Binzhou Xia	The University of Melbourne
Dr Ting Xue	The University of Melbourne
Mr James Yang	(S) The University of Sydney
Mr Kam Hung Yau	(S) University of New South Wales
Dr David Yost	Federation University Australia
Mr Jiyuan Zhang	(S) The University of Melbourne
Dr Lele (Joyce) Zhang	The University of Melbourne
Mr Rui Zhang	(S) Monash University
Dr Liangyi Zhao	University of New South Wales
Prof Sanming Zhou	The University of Melbourne
Dr Zhou Zhou	The University of Sydney
Dr Zongzheng Zhou	Monash University

Abstracts

1. Plenary

1.1. Algebraic systems of isometries

Astrid an Huef (Victoria University of Wellington)

10:30 Wed 4 December 2019 – G81
Prof Astrid an Huef

An isometry on a Hilbert space is a distance-preserving linear transformation. The algebras generated by algebraic systems of isometries are surprisingly rigid. I will consider examples of such systems arising from quasi-lattice ordered groups (G,P) where G is a discrete group with a generating submonoid P. There is a partial order on G defined by $x \le y$ if and only if $x^{-1}y \in P$. The pair (G,P) is quasi-lattice ordered if all $x, y \in G$ with a common upper bound in P have a least upper bound in P.

Quasi-lattice ordered groups and their operator algebras were introduced by Nica in 1992. I will discuss some examples of interest, including the Baumslag-Solitar group

$$G = \langle a, b : ab^c = b^d a\rangle$$

with submonoid P generated by a and b, and Thompson's group F.

1.2. On total variation flow type equations

Yoshikazu Giga (University of Tokyo)

09:00 Fri 6 December 2019 – G81
Prof Yoshikazu Giga

The classical total variation flow is the L^2 gradient flow of the total variation. The total variation of a function u is one-Dirichlet energy, i.e., $\int |Du| dx$. Different from the Dirichlet energy $\int |Du|^2 dx/2$, the energy density is singular at the place where the slope of the function u equals zero. Because of this structure, its gradient flow is actually nonlocal in the sense that the speed of slope zero part (called a facet) is not determined by infinitesimal quantity. Thus, the definition of a solution itself is a nontrivial issue even for the classical total variation flow.

Recently, there need to study various types of such equations. A list of examples includes the total variation map flow as well as the classical total variation flow and its fourth order version in image denoising, crystalline mean curvature flow or fourth order total variation flow in crystal growth problems which are important models in materials science below roughening temperature.

In this talk, we survey recent progress on these equations with special emphasis on a crystalline mean curvature flow whose solvability was left open more than ten years. We shall give a global-in-time unique solvability in the level-set sense. This last well-posedness result is based on my joint work with N. Požár (Kanazawa University) whose basic idea depends on my earlier joint work with M.-H. Giga (The University of Tokyo) and N. Požár.

1.3. When applied mathematics collided with algebra

Nalini Joshi (The University of Sydney)

09:00 Wed 4 December 2019 – G81
Prof Nalini Joshi

Imagine walking from one tile to another on a lattice defined by reflections associate with an affine Coxeter or Weyl group. Examples include triangular or hexagonal lattices on the plane. Recently, it was discovered that translations on such lattices give rise to the Painlevé equations, which are reductions of integrable systems that are more familiar to applied mathematicians and mathematical physicists. I will explain this surprising development through introductory examples and explain the background to the discovery of continuous and discrete Painlevé equations.

1.4. Unlikely intersections in arithmetic and dynamics

Holly Krieger (University of Cambridge)

11:00 Tue 3 December 2019 – South 1
Dr Holly Krieger

What does it mean for an intersection to be unlikely? I will explain the idea of unlikely intersections in arithmetic and complex dynamics, focusing on the use of arithmetic height functions in both cases. I'll discuss recent progress on these problems, particularly in the dynamical setting, and some related open questions.

1.5. Enumerative geometry via the moduli space of super Riemann surfaces.

Paul Norbury (The University of Melbourne)

10:30 Fri 6 December 2019 – G81
Prof Paul Norbury

The space of all conformal structures on a topological surface, known as the moduli space of Riemann surfaces, has been studied since Riemann's thesis in the 19th century. Mumford initiated the calculation of many algebraic topological invariants over the moduli space in the 1980s, and Witten related these invariants to two dimensional gravity in the 1990s. This viewpoint led Witten to a conjecture, proven by Kontsevich, relating a collection of integrals over the moduli space to the KdV hierarchy, which allowed their evaluation. In 2004, Mirzakhani produced another proof of Witten's conjecture via the study of Weil-Petersson volumes of the moduli space using hyperbolic geometry. In this lecture I will describe a new collection of integrals over the moduli space of Riemann surfaces also related to the KdV hierarchy. The proof uses an analogue of Mirzakhani's argument applied to the moduli space of super Riemann surfaces due to recent work of Stanford and Witten. Super Riemann surfaces are essentially defined by replacing the field of complex numbers with a Grassman algebra. This appearance of the moduli space of super Riemann surfaces to solve a problem over the classical moduli space is deep and surprising.

1.6. The mathematics problem

Leanne Rylands (Western Sydney University)

15:10 Thu 5 December 2019 – G81

Assoc Prof Leanne Rylands

The mathematics problem is the inadequate preparation of many new undergraduate students for the mathematical demands of their degree.

Many of us complain that too many students are coming to university under-prepared for the mathematical and statistical aspects of their studies. Significant numbers of under-prepared students enrolling in mathematics subjects can lead to high failure rates. High failure rates are seen as decreasing student retention and progression. High failure rates in mathematics subjects can lead to others blaming mathematicians for poor teaching, and might be used to argue for taking mathematics teaching away from mathematicians, which in turn can decrease the income of mathematics departments.

Mathematics academics have been complaining for several decades about the poor standard of new students. Is the situation really getting worse?

Much has been published about this problem. I will give an overview of some evidence to demonstrate that overall, students are less mathematically prepared than in the past. I will also consider possible actions.

1.7. Large deviations in random graphs

Wojciech Samotij (Tel Aviv University)

11:30 Fri 6 December 2019 – G81

Assoc Prof Wojciech Samotij

Suppose that $Y_1, \dots, Y_N$ are i.i.d. (independent identically distributed) random variables and let $X = Y_1 + \cdots + Y_N$. The classical theory of large deviations allows one to accurately estimate the probability of the tail events $X < (1-c)\mathbb{E}[X]$ and $X > (1+c)\mathbb{E}[X]$ for any positive c. However, the methods involved strongly rely on the fact that X is a linear function of the independent variables $Y_1, \dots, Y_N$. There has been considerable interest—both theoretical and practical—in developing tools for estimating such tail probabilities also when X is a nonlinear function of the Y_i. One archetypal example studied by both the combinatorics and the probability communities is when X is the number of triangles in the binomial random graph $G(n, p)$. I will discuss two recent developments in the study of the tail probabilities of this random variable. The talk is based on joint works with Matan Harel and Frank Mousset and with Gady Kozma.

1.8. Advancing women in Australian Mathematics: context, challenges and achievements

Joanna Sikora (Australian National University)

13:30 Tue 3 December 2019 – G81

Dr Joanna Sikora

This talk reviews recent research undertaken by social scientists on women in mathematics. First, adopting a life-course perspective it summarises findings on the persisting gap in vocational interest in mathematics among adolescent boys and girls, including its potential to widen over time. Systematic differences between boys and girls in the choice of basic and advanced mathematics for ATAR (Australian Tertiary Admissions Rank) are discussed. Next, the consequences of these choices for tertiary education specialisations and availability of suitably qualified male and female graduates are considered.

Following this introduction, the talk summarizes research on underrepresentation of women in mathematics departments in Australia and across the world. The focus is on structural and institutional process which, over the course of individual careers, can amount to significant disadvantage even in the absence of overt discrimination. Topics discussed include cultural stereotypes that link perceptions of brilliance and academic talent with masculinity, gender differences in professional capital, i.e. peer esteem, accorded to male and female mathematicians, the gender gap in rates of publications and impact, documented bias in student evaluations and factors that enable success in establishing international collaborations. The talk concludes by summarizing the literature on practical steps that managers, or heads of departments, could take to improve gender equity.

1.9. Monoids in Representation Theory, Markov Chains, Combinatorics and Operator Algebras

Benjamin Steinberg (City University of New York)

10:30 Thu 5 December 2019 – G81

Dr Benjamin Steinberg

Monoids form a natural model of irreversible phenomena and as such arise in several areas of mathematics. For example, finite state Markov chains can always be viewed as random walks of finite monoids on finite sets. Sometimes the representation theory of monoids can be used to successfully analyze the Markov chain. The representation theory of finite monoids, however, is much more complicated than the group case, which leads to interactions with the modern representation theory of finite dimensional algebras (e.g., quivers, quasi-hereditary algebras, etc.).

Monoids also appear in many guises in combinatorics. The faces of a central hyperplane arrangement, or more generally an oriented matroid, carry a natural monoid structure. The representation theory of the monoid is intimately connected with the underlying combinatorial structure. For instance the Möbius function of the geometric lattice of the underlying matroid is encoded in the Cartan matrix of the associated monoid algebra. Similar semigroup structures can be found in other geometric objects such as finite CAT(0) cube complexes.

In the theory of operator algebras, C^*-algebras generated by partial isometries play a crucial role, particularly for groupoid C^*-algebras. Such algebras are quotients of inverse semigroup algebras and this has led to a fruitful interplay between analysis, semigroup theory and the theory of groupoids. Some of the same ideas used in the representation theory of finite monoids have implications for groupoid C^*-algebras and their associated discrete analogues.

In this talk we will survey some of the surprising ways in which algebras associated to semigroups or monoids appear in mathematics and can be used to solve problems coming from outside of monoid theory.

1.10. Primes = Hard +O(1)

Timothy Trudgian (UNSW Canberra)

11:30 Thu 5 December 2019 – G81
Dr Timothy Trudgian

Suppose I give you the inequality $n^2+9 \leq 2n^2$, where n is some natural number. Clearly, this is true for all *sufficiently large n*: there are only finitely many exceptions, that is $O(1)$ exceptions. In this case we can simply enumerate the exceptions: $n = 1$ and $n = 2$, and wait for the Fields Medal Committee to come knocking.

We have known, for over 80 years, that there are $O(1)$ odd numbers N that *cannot* be written as the sum of three primes. But, unlike the above inequality, enumerating the exceptions proved very difficult. Oh, sure, $N = 1, 3, 5$ cannot be written as the sum of three primes, but even as late as the 2000s we only knew that there were no other exceptions beyond 10^{1347}. That's a big $O(1)$!

I shall outline some problems in number theory that have the flavour of the above examples, and mention some modern progress on some hard, old problems.

1.11. Shearing and mixing in surface flows

Corinna Ulcigrai (University of Zurich)

09:00 Thu 5 December 2019 – G81
Prof Corinna Ulcigrai

Flows on surfaces describe many systems of physical origin and are one of the most fundamental examples of dynamical systems, studied since Poincare'. In the last decade, there have been a lot of advances in our understanding of the chaotic properties of smooth area-preserving flows (a class which include locally Hamiltonian flows). In the talk we will motivate and survey some of the recent breakthroughs and the mechanisms, such as shearing, on which they are based, which exploit analytic, arithmetic and geometric techniques.

2. Algebra

2.1. Cocyclic Hadamard matrices of order 4p

Santiago Barrera Acevedo (Monash University)

16:00 Wed 4 December 2019 – G58

Santiago Barrera Acevedo, Padraig Ó Catháin and Heiko Dietrich

Cocyclic Hadamard matrices were introduced by de Launey and Horadam as a class of Hadamard matrices with interesting algebraic properties. Catháin and Röder described a classification algorithm for cocyclic Hadamard matrices of order 4n based on relative difference sets in groups of order 8n; this led to the classification of cocyclic Hadamard matrices of order at most 36. Based on work of de Launey and Flannery, we investigated in detail the structure of cocyclic Hadamard matrices of order 4p, with p prime. This led to a classification algorithm and the determination of cocyclic Hadamard matrices of orders 44 and 52 up to equivalence.

2.2. Presentations for diagram algebras and categories

James East (Western Sydney University)

13:30 Fri 6 December 2019 – G58

Dr James East

A presentation for an algebraic structure (e.g., a group, ring or lattice) consists of:

(1) generators, out of which each element can be built using the algebraic operations; and
(2) relations, from which all relationships between the generators can be deduced.

Presentations are very useful for a number of reasons. For one thing, you can define an action of your structure by specifying how the generators act, and then checking that the relations are preserved; this is especially helpful when the structure is complex, and the generators relatively simple.

This talk will discuss some techniques for actually obtaining presentations in the first place. It will focus primarily on diagram algebras and categories (including partition, Brauer and Temperley-Lieb), but the techniques apply to many more. In each case, the starting point is an associated diagram monoid, from which the algebras and categories can be built via a natural twisting construction.

2.3. Separating conjugacy classes in wreath products of groups

Michal Ferov (The University of Newcastle)

14:45 Wed 4 December 2019 – G58

Dr Michal Ferov

(join work with M. Pengitore) A natural way of studying groups is via studing their finite quotients. A group is said to be conjugacy separable if for every pair of non-conjugate elements there exists a finite group and surjective homomorphism onto the said group such that the images of the two elements remain non-conjugate. We study the behaviour of conjugacy separability with respect to the contructuin of wreath products, extending previous work of Remeslennikov. In particular, we classify all p-conjugacy separable wreath producs, i.e. wreath products where we only allow finite p-groups as the quotients.

2.4. Generalising the étale groupoid–complete pseudogroup correspondence

Richard Garner (Macquarie University)

13:55 Fri 6 December 2019 – G58

Dr Richard Garner

There is a well known correspondence, dating back to the earliest days of sheaf theory, between sheaves on a space X, and local homeomorphisms into X. This correspondence underlies a richer one, between *étale groupoids* and *complete pseudogroups*. An étale groupoid is a topological groupoid whose source map is a local homeomorphism; a complete pseudogroup is an inverse monoid S which acts on a space X in such a way as to make S into an X-sheaf. The étale groupoid–complete pseudogroup correspondence can be found in embryonic form in work of Ehresmann, Haefliger and Kellendonk, but reaches its abstract modern expression in work of Resende and Lawson–Lenz.

In this talk, I will explain some joint work with Robin Cockett which generalises the étale groupoid–complete pseudogroup correspondence further, along four distinct axes: by replacing inverse monoids by inverse categories; by replacing inverse monoids by restriction monoids; by enhancing the functoriality of the correspondence; and, most radically, by working not with *topological* étale groupoids, but rather with groupoids internal to a suitable join restriction category. Diverse examples will be provided to illustrate the utility of these generalisations.

2.5. Locally compact topological full groups are locally finite

Alejandra Garrido (The University of Newcastle)

17:15 Wed 4 December 2019 – G58

Dr Alejandra Garrido

Topological (a.k.a. piecewise) full groups have gained much attention in group theory in recent years as a source of infinite simple groups. They are groups of homeomorphisms of Cantor space that are "stitched up" from "pieces" of some given group of homeomorphism. This general construction can be used obtain examples of simple non-discrete totally disconnected locally compact groups. There are various choices of group topologies that one could take. I will report on joint work in progress with Colin Reid where we show that a piecewise full group which is locally compact with respect to the "obvious" choice of group topology (compact-open) is always locally finite and countable, and we give a description of these groups.

In case you wonder, there are other topologies that one can take to obtain non-discrete locally compact piecewise full groups, but these examples are a story for a different talk.

2.6. Algebras defined by equations

Marcel Jackson (La Trobe University)

16:00 Fri 6 December 2019 – G58

Marcel Jackson (speaker) joint work with Peter Higgins

The study of equationally defined classes of algebraic systems—varieties—has a long history, and continues to hold many open problems in semigroup theory. In this context, an *equation*, or *identity* is a universally quantified equality between terms. In the present talk we explore the slightly different landscape of algebraic systems described by equations with arbitrary quantification: universal or existential, in any combination. This turns out to be a useful language for axiomatically capturing a great many natural classes in semigroup theory, including the e-variety concept introduced by Tom Hall in 1989 for studying classes of regular semigroups. As an illustrative example, one finds that groups are precisely those semigroups satisfying

$$\forall a, b \exists x, y\ (ax = b\ \&\ ya = b)$$

We find that in the lattice of equationally defined classes of semigroups (in this generalised sense of equation), the finitely generated atoms are precisely those equationally defined classes generated by two element semigroups and by finite simple groups.

2.7. Varieties of semiassociative relation algebras

James Mathew Koussas (La Trobe University)

16:25 Wed 4 December 2019 – G58

Mr James Mathew Koussas

It is well known that the subvariety lattice of the variety of relation algebras has exactly three atoms. The (join-irreducible) covers of two of these atoms are known, but a complete classification of the (join-irreducible) covers of the remaining atom has not yet been found. These statements are also true of a related subvariety lattice, namely the subvariety lattice of the variety of semiassociative relation algebras. We will show that this atom has continuum many covers in this subvariety lattice using a previously established term equivalence between a variety of tense algebras and a variety of semiassociative r-algebras.

2.8. A little beyond wreath and block

Tomasz Kowalski (La Trobe University)

15:10 Fri 6 December 2019 – G58

Dr Tomasz Kowalski

(Joint work with Michal Botur, Palacky University of Olomouc, Czechia)

We present a semigroup construction generalising the two-sided wreath product. Instead of working within a direct power S^X and a K acting on X, we work with a disjoint union of sets $I[s]$ indexed by the elements of S and a system of maps (λ, ρ) between the sets $I[s]$. Intuitively and roughly, it is as if we allowed some coordinates from X to drop out from time to time, so that, for example, a product $(a, b, c, d) \cdot (u, v)$ can make sense and be equal to (av, b, cu). For any semigroups H and S this leads to what we call a $\lambda\rho$-product $G^{[S]}$. We show that:
1. $G^{[S]}$ is a group if and only if G and S are; then $G^{[S]}$ is isomorphic to the usual wreath product.
2. For semigroups, the construction is strictly more general than the known constructions; in particular, we can show that every finite semigroup divides an iterated $\lambda\rho$-product whose factors are finite simple groups and a two-element semilattice.

The first result shows that for groups we do not get anything new. The second shows that for semigroups we do. The second result, however, uses the full force of Krohn-Rhodes Theorem, so it is less exciting than it may seem.

2.9. Interpreting a radical theory identity for classes of associative rings

Robert McDougall (University of the Sunshine Coast)

13:55 Thu 5 December 2019 – G58

Dr Robert McDougall

In this talk we describe an identity involving the class operators U, S and NOT which appear in base radical theory constructions and interpret its hereditary radical class meaning for universal classes of associative rings.

2.10. Gaps in probabilities of satisfying some commutator identities

Primoz Moravec (University of Ljubljana)

14:20 Wed 4 December 2019 – G58

Prof Primoz Moravec

Let w be a non-trivial word in a free group of rank d and $w : G^d \to G$ a corresponding word map on a finite group G. Let $P_{w=1}(G) = |w^{-1}(1)|/|G|^d$ be the probability that a randomly chosen d-tuple of elements of G evaluates to 1 under the map w. There is an old result of Gustafson stating that if G is a finite non-abelian group, then the commuting probability $P_{[x,y]=1}(G)$ is bounded above by 5/8. Dixon (2004) posed a question whether or not there exists a constant $\eta < 1$ depending on w only such that for every finite group G not satisfying the law $w = 1$

we have that $P_{w=1}(G) \leq \eta$. We answer the question affirmatively for the 2-Engel word $w = [x, y, y]$ and metabelian word $w = [[x, y], [z, w]]$.

This is joint work with Costantino Delizia and Chiara Nicotera (University of Salerno, Italy), and Urban Jezernik (University of the Basque Country, Spain).

2.11. Non Fourier-Mukai functors

Amnon Neeman (Australian National University)

13:30 Thu 5 December 2019 – G58

Prof Amnon Neeman

We will describe a counterexample, due to Rizzardo and Van den Bergh, saying that not all maps between derived categories of smooth projective varieties are Fourier-Mukai. I will describe my contribution to the paper, which produced a vast source of potential new examples.

2.12. Simply transitive NIL-affine actions of solvable Lie groups

Marcos Origlia (Monash University)

15:35 Wed 4 December 2019 – G58

Dr Marcos Origlia

Every simply connected and connected solvable Lie group G admits a simply transitive action on a nilpotent Lie group H via affine transformations. Although the existence is guaranteed, not much is known about which groups G can act simply transitive on which groups H. So far the focus was mainly on the case where G is also nilpotent.

In this talk, we will discuss the case when G is a solvable (non-nilpotent) Lie group and H is a nilpotent Lie group. This is a work in progress with Jonas Deré (KU Leuven, Belgium).

2.13. Takiff superalgebras and conformal field theory

Thomas Quella (The University of Melbourne)

15:35 Fri 6 December 2019 – G58

Dr Thomas Quella

We discuss Takiff superalgebras from the perspective of applications in conformal field theory. Takiff superalgebras arise from a truncated loop algebra construction and the focus of the talk will be on the existence of invariant forms, automorphisms and compatibility with affinization (the full loop algebra construction).

2.14. Locally compact piecewise full groups of homeomorphisms of the Cantor set

Colin David Reid (The University of Newcastle)

17:40 Wed 4 December 2019 – G58

Dr Colin David Reid

Let X be the Cantor set and let Homeo(X) be the group of homeomorphisms from X to itself. Say that a subgroup G of Homeo(X) is piecewise full if, whenever g in Homeo(X) is such that the action of g can be specified by a locally constant element of G, then in fact g is in G.

Piecewise full groups (also called topological full groups) have been an active area of research since the 1990s, with most authors focusing on the case where the group is countable. More recently, piecewise full groups have emerged as a rich source of examples of nondiscrete (hence uncountable) simple locally compact groups, and they have some interesting universality properties in the class of totally disconnected locally compact groups. I will talk about some results of ongoing work with A. Garrido and D. Robertson.

2.15. Skeleton groups and their isomorphism problem

Subhrajyoti Saha (Monash University)

13:55 Wed 4 December 2019 – G58

Mr Subhrajyoti Saha

Classification of groups up to isomorphism is one of the main themes in group theory. A particular challenge is to understand finite p-groups, that is, groups of p-power order for a prime p. Since a classification of p-groups by order seems out of reach for large exponents n, other invariants of groups have been used to attempt a classification; a particularly intriguing invariant is coclass. A finite p-group of order p^n and nilpotency class c has *coclass* $r = n - c$. The investigation of p-groups by coclass has been initiated by Leedham-Green and Newman, and numerous deep results have been obtained since then.

Recent work in coclass theory is often concerned with the study of the *coclass graph* $\mathcal{G}(p, r)$ associated with the finite p-groups of coclass r. The vertices of the coclass graph $\mathcal{G}(p, r)$ are (isomorphism type representatives of) the finite p-groups of coclass r, and there is an edge $G \to H$ if and only if G is isomorphic to $H/\gamma(H)$ where $\gamma(H)$ is the last non-trivial term of the lower central series of H. It is known that large parts of this infinite graph have periodic patterns and that these patterns are reflected in the structures of the involved groups. It has also become apparent that one of the feasible approaches for investigating $\mathcal{G}(p, r)$ is to first focus on so-called *skeleton groups*. For odd p, let S be an infinite pro-p group and informally skeleton groups can be described as twisted finite quotients of S, where the *twisting* is induced by some suitable homomorphism. The importance of these groups is explained by the deep result that, with only finitely many exceptions, every group G in $\mathcal{G}(p, r)$ has a *bounded* depth from a skeleton group. This justifies saying that these groups indeed form the 'skeleton' of $\mathcal{G}(p, r)$. We further investigate when two skeleton groups are isomorphic. We present some results towards this direction including two interesting cases. During our work we also identified a number of gaps in some recent work and we close these gaps by proving the required results in a more general context.

This is a joint work with Dr. Heiko Dietrich, Monash University, Australia.

2.16. On exceptional Lie geometries

Jeroen Schillewaert (University of Auckland)

13:30 Wed 4 December 2019 – G58

Dr Jeroen Schillewaert

Parapolar spaces are point-line geometries introduced as a geometric approach to (exceptional) algebraic groups. We provide a characterisation of a wide class of Lie geometries as parapolar spaces satisfying a simple intersection property. In particular many of the exceptional Lie geometries occur. In fact, our approach unifies and extends several earlier characterizations of (exceptional) Lie geometries arising from spherical Tits-buildings.

(This is joint work with Anneleen De Schepper, Hendrik Van Maldeghem and Magali Victoor)

2.17. Demonic composition and inverse semigroups.

Tim Stokes (University of Waikato)

14:20 Fri 6 December 2019 – G58

Dr Tim Stokes

Most people are familiar with the definition of composition of two binary relations. This operation generalises composition of functions and is associative. A less well-known operation on relations is so-called demonic composition, which is more restricted than ordinary composition, and is of interest because it arises naturally when modelling non-deterministic computer programs. Demonic composition is also associative, and also generalises function composition. Why is it so nicely behaved? We show how it fits into a much more general framework that applies to Baer $*$-semigroups (such as the multiplicative semigroups of $*$-regular rings) and beyond. In particular we may define the “demonic product" of two $n \times n$ real or complex matrices, which almost always agrees with the usual matrix product but which gives an unexpected inverse semigroup structure on such matrices, where inverses are nothing but Moore-Penrose inverses.

2.18. On properties of descending chains

Lauren Thornton (University of the Sunshine Coast)

16:50 Wed 4 December 2019 – G58

Miss Lauren Thornton

We give a complete description up to isomorphism of the way descending chains of ideals for universal class objects in a general setting can terminate with consequences for structures like groups and rings. We show that while some ideals arise because they satisfy a condition held by the elements of the class object, their existence can also be inferred as an outcome of the structural requirements framed by the class setting.

2.19. Some Remarks on monoids of contraction mappings of a finite chain

Abdullahi Umar (Khalifa University of Science, Technology)

14:20 Thu 5 December 2019 – G58

Dr Abdullahi Umar

A general systematic study of the monoids/semigroups of partial contractions of a finite chain and their various subsemigroups of order-preserving/order-reversing and/or order-decreasing transformations was initiated in 2013 supported by a grant from The Research Council of Oman (TRC).

Our aim in this talk is to present the results obtained so far by the presenter and his co-authors as well as others. Broadly, speaking the results can be divided into two groups: algebraic and combinatorial enumeration. The algebraic results show that these semigroups are nonregular (left) abundant semigroups (for $n \geq 4$) whose Green's relations admit a nontrivial characterization. The combinatorial enumeration results show links with Fibonacci numbers, Motzkin numbers and sequences some of which are in the encyclopedia of integers sequences (OEIS).

3. Applied and Industrial Mathematics

3.1. Applications of temporally regularised matrix factorisations to the analysis of climate data

Dylan Harries (CSIRO)

14:20 Tue 3 December 2019 – 189

Dr Dylan Harries

A ubiquitous step in analyses of climate data is the application of an initial dimension reduction method to obtain a low-dimensional representation that retains the relevant features of the data, while also being tractable to analyse. Standard methods such as principal component analysis (PCA) are highly efficient for this purpose, but can yield results that are difficult to interpret physically, and rely on assumptions of stationarity and independence that are generally not satisfied by the data. One approach to rectifying these shortcomings is to consider alternative factorisations from the broader class of matrix decompositions from which PCA arises as a special case. In particular, doing so allows for the use of regularisations tailored towards the selection of the most salient features in the data for a given analysis, and for the explicit modelling of dependence between samples. In this talk, we demonstrate the application of a recently proposed convex coding method incorporating temporal regularisations chosen to target the large scale, persistent structures associated with low-frequency climate variability, and compare the performance of the method with traditional strategies such as PCA and k-means clustering.

3.2. DOBIN: dimension reduction for outlier detection

Sevvandi Priyanvada Kandanaarachchi (Monash University)

16:50 Tue 3 December 2019 – 189

Dr Sevvandi Priyanvada Kandanaarachchi

Outlier detection is used in diverse applications ranging from finance to extreme weather conditions. A common challenge in outlier detection is that a data point may be an outlier in the original high dimensional space, but not an outlier in the low dimensional subspace created by a dimension reduction method. In this talk, we introduce a new set of basis vectors called DOBIN designed for outlier detection. DOBIN brings outliers to the forefront making it easier to detect them. We demonstrate DOBIN's effectiveness using an extensive data repository. In addition, we present some interesting examples of outlier visualization using DOBIN.

3.3. Ensemble transform Kalman filter estimation of thermodynamic parameters in a coupled general circulation model

Vassili Kitsios (CSIRO)

16:25 Tue 3 December 2019 – 189

V. Kitsios, P. Sandery, T. J. O'Kane, P. Sakov and R. Fiedler

In climate simulations there are many model parameters that are known with little precision. The biases observed in these complex multi-disciplinary multi-scale simulations can be highly sensitive to the specification of such parameters. Within a data assimilation (DA) framework we develop a systemic approach to estimate such model parameters, with the intention to reduce model bias and hence improve forecast skill.

In general, DA provides the ability to modify imperfect simulations of reality with a series of incomplete and possibly noisy measurements, ideally resulting in a better estimation of the true system state, and also potentially an estimate of the model parameters. For the experiments undertaken within, we adopt the CSIRO Climate Analysis Forecast Ensemble system, which employs the ensemble transform Kalman filter first proposed by Bishop et. al. (2001), and specifically the implementation of Sakov (2014). The system is run with an ensemble of 96 forward climate simulations. The forward model is the Geophysical Fluid Dynamics Laboratory coupled atmospheric, oceanic, and sea-ice climate simulator as described in Griffies (2012). An earlier iteration of the CAFE system is documented in O'Kane et. al. (2018).

Using this configuration we identify spatio-temporally varying parameters that minimise the error between short term (daily to weekly) forecasts of the coupled climate model and a network of real world atmospheric, oceanic, and sea-ice observations. The parameters of interest are the surface ocean albedo, and the ocean penetration depth of incoming shortwave radiation. These parameters are shown to have a significant impact on the short term predictability of the underlying model. We look to determine if parameters estimated from within a DA training period to optimise many short term forecasts, can reduce the onset of model bias in longer term (multi-year) forecasts.

3.4. Simple Markovian closures for inhomogeneous turbulence

Terry O'Kane (CSIRO)

15:10 Tue 3 December 2019 – 189

Drs Terry O'Kane and Jorgen S. Frederiksen

Markovian closures for the interaction of two-dimensional inhomogeneous turbulent flows with Rossby waves and topography are formulated based on three variants of the fluctuation dissipation theorem (FDT) i.e. the current-time (quasi-stationary) FDT, the prior-time (non-stationary) FDT and the correlation FDT. The Markovian inhomogeneous closures (MIC) are established from the quasi-diagonal direct interaction approximation (QDIA) theory by modifying the response function to a Markovian form and employing the respective FDT variants.

In the MICs, Markov equations for the triad relaxation functions are derived that carry similar information to the time-history integrals of the non-Markovian QDIA closure. A further approximation is applied whereby analytic forms for the triad relaxation rates are formulated. The resulting simple Markovian inhomogeneous closure is analagous to the eddy damped quasi-normal (EDQNM) approximation developed by Orszag (1970) for homogeneous isotropic turbulence. The MICs are considerably more computationally efficient for long integrations as compared to the QDIA allowing, for the first time, investigation of inertial ranges using inhomogeneous statistical dynamical closures.

Far from equilibrium processes are studied, including the impact of a westerly mean flow on a conical mountain generating large-amplitude Rossby waves in a turbulent environment, as well as observed tropospheric flows including atmospheric blocking phenomena. In general, excellent agreement is found between the evolved mean streamfunction and mean and transient kinetic energy spectra for the three versions of the MIC and two variants of the non-Markovian QDIA compared with an ensemble of 1800 direct numerical simulations (DNS).

3.5. Approximating Link Travel Time Distributions

Samithree Rajapaksha (Monash University)

16:00 Tue 3 December 2019 – 189

Mrs Samithree Rajapaksha, A/Prof. Tim Garoni and Dr Lele Zhang

Investigating link travel time distributions is important for modelling vehicular dynamics in arterial roads. Most studies related to travel time distributions are limited to empirical estimations. However, results tend to be inconclusive. We proposed a model based on Negative Binomial distributions to approximate link travel time distributions and evaluated its performance against a simple stochastic transport model, Asymmetric Simple Exclusion Process (ASEP).

3.6. Courier route optimization with unloading bays information and reservation systems

Lele (Joyce) Zhang (The University of Melbourne)

17:15 Tue 3 December 2019 – 189

Dr Lele (Joyce) Zhang

The demand for parcel deliveries in central city areas has been growing fast as a result of rapid urbanization and the development of e-commerce. Finding efficient routes for couriers undertaking deliveries in those areas is becoming more challenging due to growing levels of congestion and difficulties in accessing unloading bays. Developments in advanced on-line booking systems and sensor technologies provide great opportunities to improve delivery efficiency and the utilization of unloading bays, and further to improve urban sustainability and livability. We developed a stochastic agent-based simulation model to study the benefits of providing couriers with unloading bay availability information and reservation opportunities, within which a two-layer optimization model for the courier multimodal routing problem. Numerical experiments were conducted on a network similar to Melbourne's CBD. It was found that when real-time average occupancy or instantaneous availability information is provided total delivery times are decreased due to substantial savings in driving arising from less circulation and searching for unoccupied unloading bays. Such a positive effect is more pronounced when no parking duration limits are applied, and lower driving distances lead to better environmental performance. In addition, the unloading bay management authorities could coordinate the behavior of couriers via intelligently assigning reservations based on delivery demand. In that case, the reservation system can guarantee the availability of unloading bays for couriers so that uncertainty in undertaking deliveries can be greatly reduced and service quality and reliability can be enhanced. The coordination enables the delivery network to realize a system-wide optimization, which can lead to approximately 38

4. Category Theory

4.1. Characterising split opfibrations using lenses

Bryce Clarke (Macquarie University)

16:00 Wed 4 December 2019 – 188

Bryce Clarke

Split opfibrations are functors equipped with a suitable choice of opcartesian lifts, and are perhaps best known as arising from Cat-valued functors under the Grothendieck construction. When working in a 2-category, split opfibrations may instead be defined as algebras for a particular 2-monad, however when specialising to Cat this is quite different from the ordinary definition. In this talk, I will use lenses to introduce two alternative ways of defining split opfibrations in Cat: the first utilising double categories and the second utilising the décalage of a category. I will explore how these definitions are linked and show how they are generalised to the 2-category of internal categories.

4.2. The free tangent category on an affine connection

Richard Garner (Macquarie University)

13:30 Wed 4 December 2019 – 188

Dr Richard Garner

A tangent category is a category $\mathscr{C}$ endowed with an endofunctor $T\colon \mathscr{C} \to \mathscr{C}$ which behaves like the tangent space functor on the category of smooth manifolds. It provides an abstract setting for differential geometry, with instantiations including not only the motivating example of smooth manifolds, but also categories of schemes, of deformation problems, and of cocommutative coalgebras, as well as examples coming from differential programming in theoretical computer science.

In a tangent category, there is a good notion of *affine connection* on an object. In this talk, I will describe joint work with Geoff Cruttwell which describes the free tangent category on an object with an affine connection. The key idea is to encode the multilinear calculus of $(1,n)$-tensor fields on such an object, which we do by way of a notion of "operad with affine connection". The punchline is that the free tangent category on an affine connection is exactly the Lawvere theory generated by the free operad with affine connection.

4.3. t-structures and approximable triangulated categories

Bregje Pauwels (The University of Sydney)

16:25 Wed 4 December 2019 – 188

Dr Bregje Pauwels

Given a bounded-above cochain complex of modules over a ring, it is standard to replace it by a projective resolution, and it is classical that doing so can be very useful.

Recently, Amnon Neeman introduced a modified version of this idea in triangulated categories other than the derived category of a ring. A triangulated category is approximable if this modified procedure is possible. The concept of approximability has led to exciting new results, some of which I will discuss in this talk. In particular, I will give sufficient conditions for when objects in a triangulated category T generate the aisle of a t-structure on T.

4.4. Localising by spans and cospans, and functoriality of associated algebras

David Roberts (The University of Adelaide)

16:50 Wed 4 December 2019 – 188

Dr David Roberts

The 2-category of presentable stacks is a localisation of the 2-category of groupoids internal to the base site at the trivial isofibrations (defined appropriately). It is equivalently the localisation of the sub-2-category of groupoids with complemented cofibrations as 1-morphisms at the trivial cofibrations, with mild extra assumptions on the base site. Both constructions are special cases of an abstract construction of a bicategory of fractions, with very little assumed about the site. This can be used when discussing the functoriality of the $*$-algebra associated to a groupoid, and, more generally the C^*-algebra associated to more structured groupoids. This is work in progress.

4.5. An embedding of the homotopy theory of 2-categories into that of 2-complicial sets

Martina Rovelli (The Australian National University)

15:35 Wed 4 December 2019 – 188

Viktoriya Ozornova and Martina Rovelli

It is desirable that a good candidate model for the homotopy theory of (∞,n)-categories should interact nicely with the existent homotopy theory of strict n-categories. When $n = 0,1$, it is understood that the homotopy theory of sets and of strict 1-categories embeds in that of ∞-categories and ∞-groupoids, essentially for all existing models. When $n = 2$ and we consider 2-complicial sets as a model of $(\infty,2)$-categories, the picture is more complicated. In this talk we will give an informal introduction to 2-complicial sets and describe a homotopically fully faithful nerve construction that embeds the homotopy theory of 2-categories in the $(\infty,2)$-categories in the form of 2-complicial sets. This is joint work with V. Ozornova.

4.6. Graphical Sets and Mapping Class Groups

Michelle Strumila (The University of Melbourne)

14:20 Wed 4 December 2019 – 188

Ms Michelle Strumila

Infinity operads can be modelled by dendroidal sets via the category of trees. When generalised to the category of graphs, one obtains a model for infinity modular operads. One would hope, then, that infinity modular operads satisfy some analogue of the nerve theorem; indeed, they do. Additionally, I have created a topological example of an infinity modular operad. This involves mapping class groups of surfaces, and in interesting because it comes at it from the graphical set perspective.

4.7. Regular Theories Enriched Over Finitary Varieties

Giacomo Tendas (Macquarie University)

14:45 Wed 4 December 2019 – 188

Mr Giacomo Tendas

When talking about theories we may think of two different approaches, a logical one and a categorical one. From the logical point of view, a theory is given by a list of axioms on a fixed set of operations, and its models are corresponding sets and functions that satisfy those axioms. For instance algebraic theories are those whose axioms consist of equations based on the operation symbols of the language (e.g. the axioms for abelian groups or rings). More generally, if the axioms are still equations but the operation symbols are not defined globally, but only on equationally defined subsets, we talk of essentially algebraic theories. A further step can be made by considering regular theories, in which we allow existential quantification over the usual equations.

Categorically speaking, we could think of a theory as a category C with some structure, and of a model of C as a functor from C into Set which preserves that structure; this approach was first introduced by Lawvere. Algebraic theories then correspond to categories with finite products, and models are finite product preserving functors. On the other hand a category with finite limits represents an essentially algebraic theory, and functors preserving finite limits are its models. Regular theories correspond instead to regular categories: finitely complete ones with coequalizers of kernel pairs, for which regular epimorphisms are pullback stable. Models here are functors preserving finite limits and regular epimorphisms; we refer to them as regular functors.

These two notions, categorical and logical, can be recovered from each other: given a logical theory, there is a syntactic way to build a category with the relevant structure for which models of the theory correspond to functors to Set preserving this structure, and vice versa.

In the context of regular theories, Barr showed that each small and regular category C can be embedded in a particular category of presheaves based on the models of C; then in 1990 Makkai gave a simple explicit characterization of the essential image of the embedding (in the case where the original regular category is moreover exact), giving a simple way to recover a theory from its models.

In this talk we define an enriched notion of regularity, and prove a corresponding version of the theorems of Barr and Makkai; all of this is done enriching over finitary varieties: categories of the form FP(C,Set), consisting of finite product preserving functors for some small category C with finite products.

Joint work with Steve Lack

5. Combinatorics and Graph Theory

5.1. Generation of random graphs with given degrees

Andrii Arman (Monash University)

15:10 Tue 3 December 2019 – G56

Dr Andrii Arman

In this talk I will discuss algorithms for a uniform generation of random graphs with a given degree sequence. Let M be the sum of all degrees and Δ be the maximum degree of a given degree sequence. McKay and Wormald described a switching based algorithm for the generation of graphs with given degrees that had expected runtime $O(M^2\Delta^2)$, under the assumption $\Delta^4 = O(M)$. I will present a modification of the McKay-Wormald algorithm that incorporates a new rejection scheme and uses the same switching operation. A new algorithm has expected running time linear in M, under the same assumptions.

I will also describe how a new rejection scheme can be integrated into other graph generation algorithms to significantly reduce expected runtime, as well as how it can be used to generate contingency tables with given marginals uniformly at random.

This talk is based on the joint work with Jane Gao and Nick Wormald.

5.2. How generic ring algorithms and labelled binary trees helped solve an outstanding factoring problem in number theory.

Lynn Batten (Deakin University)

13:55 Thu 5 December 2019 – G56

Prof Lynn Batten

We show how generic ring algorithms can be identified with rooted partially labelled binary trees where branches in the tree correspond to equality queries, and non-branching vertices correspond in a natural way to polynomials. We then describe how Aggarwal and Maurer, in 2016, used this identification to prove the existence of a probabilistic polynomial time algorithm taking as input a product of two prime numbers and factoring this with probability greater than or equal to one half.

5.3. Universal Bijections for Positive Algebraic Structures

Richard Brak (The University of Melbourne)

17:15 Tue 3 December 2019 – G56

Dr Richard Brak

Many well know combinatorial families (Catalan, Motzkin, Schroeder, Catalan-Fuss, ...) are examples of positive algebraic structures (a certain condition on the algebraic equation the ordinary generating satisfies). We will show that all such structures can be given a generalised magma structure. If the magma is free then the universal isomorphism between generalised magma of the same type define a universal recursive size preserving bijection between all such structures eg. a single bijection that applies to any pair of Catalan structures. We also provide a combinatorial theorem that characterises a generaised free magma.

5.4. The firebreak problem

Andrea Burgess (University of New Brunswick)

14:20 Thu 5 December 2019 – G56

Kathleen Barnetson, Andrea Burgess, Jessica Enright, Jared Howell, David Pike, Brady Ryan

Suppose a network is represented by a graph G. A fire (or some sort of contagion) breaks out at a vertex, and we may respond by establishing a firebreak by protecting k other vertices of G. The fire cannot burn or pass through these k protected vertices; however, the fire subsequently spreads to all vertices it can reach without passing through the firebreak. A natural question arises: how many vertices can we save from being burned?

In this talk, we consider the corresponding decision problem. We show that this problem is intractable on split graphs and bipartite graphs, but polynomial-time solvable on several other graph classes, such as cubic graphs and graphs with bounded treewidth.

5.5. Heffter Arrays with compatible and simple orderings

Nicholas Cavenagh (University of Waikato)

13:30 Wed 4 December 2019 – G56

Dr Nicholas Cavenagh

In the last 20 years biembedding pairs of designs and cycle systems onto surfaces has been a much-researched topic (see the 2007 survey "Designs and Topology" by Grannell and Griggs). In particular, in a posthumous work (2015), Archdeacon showed that biembeddings of cycle systems may be obtained via Heffter arrays. Formally, a Heffter array $H(m,n;s,t)$ is an $m \times n$ array of integers such that:

- each row contains s filled cells and each column contains t filled cells;
- the elements in every row and column sum to 0 in $\mathbb{Z}_{2ms+1}$; and
- for each integer $1 \le x \le ms$, either x or $-x$ appears in the array.

If we can order the entries of each row and column satisyfing two properties (compatible and simple), a Heffter array yields an embedding of two cycle decompositions of the complete graph K_{2ms+1} onto an orientable surface. Such an embedding is face 2-colourable, where the faces of one colour give a decomposition into s-cycles and the faces of the other colour gives a decomposition into t-cycles. Thus as a corollary the two graph decompositions are *orthogonal*; that is, any two cycles share at most one edge. Moreover, the action of addition in $\mathbb{Z}_{2ms+1}$ gives an automorphism of the embedding. We give more detail about the above and present a new result: the existence of Heffter arrays $H(n, n; s, s)$ with compatible and simple orderings whenever $s \equiv 3 \pmod 4$ and $n \equiv 1 \pmod 4$.

5.6. Properties of the polytope of polystochastic matrices

William Crawford (Monash University)

17:15 Wed 4 December 2019 – G56

Mr William Crawford

A d-dimensional matrix is called 1-*polystochastic* if it is non-negative and the sum over each line equals 1. Such a matrix that has a single 1 in each line and zeros elsewhere is called a 1-*permutation* matrix. A *diagonal* of a d-dimensional matrix of order n is a choice of n elements, no two in the same hyperplane. The *permanent* of a d-dimensional matrix is the sum over the diagonals of the product of the elements within the diagonal.

For a given order n and dimension d, the set of 1-polystochastic matrices forms a convex polytope that includes the 1-permutation matrices within its set of vertices. For even n and odd d, we give a construction for a class of 1-permutation matrices with zero permanent. Consequently, we show that the set of 1-polystochastic matrices with zero permanent contains at least $n^{n^{3/2}(1/2-o(1))}$ 1-permutation matrices and contains a polytope of dimension at least $cn^{3/2}$ for fixed c, d and even $n \to \infty$. We also provide counterexamples to a conjecture by Taranenko about the location of local extrema of the permanent.

5.7. MaxMinSum Steiner Systems for Access-Balancing in Distributed Storage

Son Hoang Dau (RMIT University)

16:00 Fri 6 December 2019 – G56

Dr Son Hoang Dau

Many code families such as low-density parity-check codes, fractional repetition codes, batch codes, and private information retrieval codes with low storage overhead rely on the use of combinatorial block designs or derivatives thereof. In the context of distributed storage applications, one is often faced with system design issues that impose additional constraints on the coding schemes and therefore on the underlying block designs. Here, we address one such problem, pertaining to server access frequency balancing, by introducing a new form of Steiner systems, termed MaxMinSum Steiner systems. MaxMinSum Steiner systems are characterized by the property that the minimum value of the sum of points (elements) within a block is maximized or that the minimum sum of block indices containing some fixed point is maximized. We show that proper relabelings of points in the Bose and Skolem constructions for Steiner triple systems lead to optimal MaxMin values for the sums of interest; for the duals of the designs, we exhibit block labelings that are within a 3/4 multiplicative factor from the optimum.

5.8. On determining when small embeddings of partial Steiner triple systems exist

Ajani De Vas Gunasekara (Monash University)

13:55 Wed 4 December 2019 – G56

Darryn Bryant, Ajani De Vas Gunasekara, Daniel Horsley

A *partial Steiner triple system* of order u is a pair $(U, \mathscr{A})$ where U is a set of u vertices and $\mathscr{A}$ is a set of triples of elements in U such that any two elements of U occur together in at most one triple. If each pair of elements occur together in exactly one triple it is a *Steiner triple system*. An *embedding* of a partial Steiner triple system $(U, \mathscr{A})$ is a (complete) Steiner triple system $(V, \mathscr{B})$ such that $U \subseteq V$ and $\mathscr{A} \subseteq \mathscr{B}$. For a given partial Steiner triple system of order u it is known that an embedding of order $v \geq 2u+1$ exists whenever v satisfies the obvious necessary conditions. Determining whether "small" embeddings of order $v < 2u+1$ exist is a more difficult task. Here we extend a result of Colbourn on the NP-completeness of these problems.

5.9. Some problems suggested by the Online Graph Atlas project

Graham Farr (Monash University)

17:40 Wed 4 December 2019 – G56

Prof Graham Farr

The Online Graph Atlas (OLGA) is an electronic repository of all graphs (up to isomorphism) up to some order (currently 10), together with values of several important parameters for each graph. It has been built at Monash University and was originally inspired by the printed repository of Read and Wilson. The latest version has been built by Srinibas Swain in collaboration with Paul Bonnington, Graham Farr and Kerri Morgan. In this talk, we present some graph-theoretic questions raised by this project.

One family of questions we consider is the following. Let f be a nonnegative integer-valued graph parameter, invariant under isomorphism. We seek to calculate f recursively, using its values on subgraphs obtained by deleting single vertices or single edges. Sometimes — e.g., if f is circumference — this can be done exactly, and this is useful as it helps us calculate the values of f efficiently for all graphs in the repository. At other times, we do not know of an exact recurrence, but it is often the case that we can still find simple recursive upper and lower bounds. For example, in some situations — such as if f is tree-width or degeneracy — we may be able to show that, for all $v \in V(G)$,

$$\max\{f(G-v) \mid v \in V(G)\} \leq f(G) \leq 1+\min\{f(G-v) \mid v \in V(G)\}.$$

For such an f, we are especially interested in how often these bounds coincide, because in such cases we know the value of f exactly. When the bounds do not coincide, we must resort to some other method to compute f, and this may be costly.

Let the proportion of n-vertex graphs for which the bounds coincide be $\mu_f(n)$. We ask:

(1) Do there exist constants $L_f > 0$ and $U_f < 1$ such that $L_f \leq \mu_f(n) \leq U_f$ for all sufficiently large n?
(2) Does $\lim_{n\to\infty} \mu_f(n)$ exist?

These questions may be asked for any f. We discuss some specific parameters and report some computational results for them.

This is joint work with Srinibas Swain, Paul Bonnington and Kerri Morgan.

5.10. Learning Large Random Graphs Via Group Queries

Matthias Fresacher (University of Adelaide)

16:25 Tue 3 December 2019 – G56

Mr Matthias Fresacher

This report examines algorithms that learn large random graphs via nonadaptive noiseless group queries. Specifically, it examines how to minimise the number of testes required to fully learn a random graph. The analysis draws on techniques from group testing and applies them in a random graph setting.

In particular, the COMP algorithm is analysed and a theoretical upper bound on the number of test required established. A theoretically algorithm-independent lower bound is also examined to provide a lower bound on the number of tests required to provide a comparison. Both of these bounds hold for most scaling regimes of interest in regard to the number of edges and nodes contained in the random graph.

Further, the learning of random graphs is shown to be solvable using ILP and LP techniques. These algorithms along with the DD algorithm are then compared in simulations in an attempt to empirically verify the theoretical results.

5.11. Perfect 1-factorisations of K_{16}

Michael James Gill (Monash University)

16:50 Wed 4 December 2019 – G56

Mr Michael James Gill

A 1-factorisation of the complete graph K_{2n} is perfect if the union of each pair of 1-factors is a Hamiltonian cycle. Dinitz and Garnick (1996) found 23 perfect 1-factorisations of K_{14}. Meszka and Rosa (2003) found 88 perfect 1-factorisations of K_{16} with non-trivial automorphisms. Using partially ordered traversal techniques and edge selection heuristics, we found all 3155 perfect 1-factorisations of K_{16} including 89 with non-trivial automorphisms. We evaluated the efficacy of two well studied isomorphism invariants and proposed two new isomorphism invariants. We also proved the non-existence of a symmetric atomic Latin square of order 15.

5.12. New bounds on the maximum size of Sperner partition systems

Adam Gowty (Monash University)

14:20 Wed 4 December 2019 – G56

Mr Adam Gowty

An (n,k)-Sperner partition system is a collection of partitions of an n-set into k nonempty classes, that satisfies the requirement that no class is a subset of another. In this talk, we shall discuss a construction for Sperner partitions systems that, as $\frac{n}{k}$ grows large, produces systems for which the number of partitions they contain is asymptotic to the best possible.

5.13. Constructions of Difference Covering Arrays using Skolem sequences

Joanne Hall (Royal Melbourne Institute of Technology)

15:10 Fri 6 December 2019 – G56

Joanne Hall and Asha Rao

Difference Covering Arrays (DCA) are a generalisation of difference matrices, and provide a useful tool for experimental designs. Difference covering arrays can be used to construct mutually orthogonal Latin squares, transversal coverings, and covering arrays, with applications in software testing, error correcting codes, and experimental design. We use Skolem sequences to construct new families of DCA, and classify isomorphism classes of DCA.

5.14. Covering radius in the Hamming permutation space

Kevin Hendrey (Institute for Basic Science)

16:25 Fri 6 December 2019 – G56

Kevin Hendrey, Ian M. Wanless

Our problem can be described in terms of a two player game, played with the set $\mathcal{S}_n$ of permutations on $\{1,2,\ldots,n\}$. First, Player 1 selects a subset S of $\mathcal{S}_n$ and shows it to Player 2. Next, Player 2 selects a permutation p from $\mathcal{S}_n$ as different as possible from the permutations in S, and shows it to Player 1. Finally, Player 1 selects a permutation q from S, and they compare p and q. The aim of Player 1 is to ensure that p and q differ in few positions, while keeping the size of S small. The function $f(n,s)$ can be defined as the minimum size of a set $S \subseteq \mathscr{S}_n$ that Player 1 can select in order to gaurantee that p and q will differ in at most s positions.

I will present some recent results on the function $f(n,s)$. We are particularly interested in determining the value $f(n,2)$, which would resolve a conjecture of Kézdy and Snevily that implies several famous conjectures for Latin squares. Here we improve the best known lower bound, showing that $f(n,2) \geqslant 3n/4$. Joint work with Ian M. Wanless.

5.15. Generating digraphs with derangements

Daniel Horsley (Monash University)
14:45 Wed 4 December 2019 – G56
Daniel Horsley, Moharram Iradmusa, Cheryl E. Praeger

A collection $\mathscr{S}$ of derangements of a set V generates a (possibly infinite) digraph with vertex set V and arc set $\{(x,\sigma(x)) : x \in V, \sigma \in \mathscr{S}\}$. Here we characterise, for each positive integer k, the digraphs that can be generated by at most k derangements. Our result resembles the De Bruijn-Erdős theorem in it characterises a property of an infinite graph in terms of properties of its finite subgraphs.

5.16. Excluded minors for classes of binary functions

Benjamin Jones (Monash University)
14:20 Tue 3 December 2019 – G56
Mr Benjamin Jones

The rank of a set of edges in a graph is the size of the largest forest contained in that set. It is well known that the deletion and contraction operations can be expressed in terms a graph's rank function, and the operations generalise to rank functions of other combinatorial structures, including matroids and polymatroids.

In (Farr, 1993), every rank function $r : 2^E \to \mathbb{R}$ is assigned a *binary function* $Q^\dagger r : 2^E \to \mathbb{R}$ by the transform $Q^\dagger$, given by

$$Q^\dagger r(X) := (-1)^{|X|} \sum_{Y \subseteq X} (-1)^{|Y|} 2^{r(E)-r(E\setminus Y)}.$$

When r is the rank function of a binary matroid, $Q^\dagger r$ is the indicator function of its associated binary vector space (cocircuit space). For graph rank functions, this is the space generated by the minimal edge cutsets. The deletion and contraction operations were extended to binary functions.

In this talk, we examine some minor-closed classes of rank functions using binary functions, and determine their excluded minors within the class of binary functions. These include the classes of binary matroids, matroids and polymatroids. This approach yields a new proof of Tutte's excluded minor characterisation of binary matroids, by looking at their excluded minors in the more general class of binary functions.

5.17. An improved lower bound on Hong and Loewy's numbers

Vesa Kaarnioja (University of New South Wales)
15:35 Fri 6 December 2019 – G56
Dr Vesa Kaarnioja

Let K_n be the set of all nonsingular $n \times n$ lower triangular Boolean matrices. Hong and Loewy (2004) introduced the numbers

$$c_n := \min\{\lambda \mid \lambda \text{ is an eigenvalue of } XX^{\mathrm{T}},\ X \in K_n\}, \quad n \in \mathbb{Z}_+.$$

These numbers appear, e.g., in the estimation of the spectral radii of GCD and LCM matrices as well as their lattice-theoretic counterparts.

In this talk, we present a new lower bound for the numbers c_n. This bound improves the previous estimates derived by Mattila (2015) and Altınışık et al. (2016). The sharpness of this lower bound is assessed numerically, which leads us to conjecture that $c_n \sim 5\varphi^{-2n}$ as $n \to \infty$.

5.18. A curious bijection between Dyck paths

Kevin Limanta (University of New South Wales)
17:40 Tue 3 December 2019 – G56
Mr Kevin Limanta

Given a two-dimensional integer lattice $\mathbb{Z}^2$, one can construct a lattice path starting at $(0,0)$ which consists of up-steps $(1,1)$ and down-steps $(1,-1)$. A Dyck path of semi-length n (or of length $2n$) is such a lattice path between $(0,0)$ and $(2n,0)$ which never goes below the x-axis. It is well-known that the number of all Dyck paths of semi-length n is the nth Catalan number given by the sequence A000108 in OEIS. In this talk, I will describe an interesting bijection between the set of Dyck paths of semi-length n which was motivated by a bijection given by Elizalde and Deutsch.

5.19. On the Cyclic Matching sequenceablility of regular graphs

Adam Mammoliti (Monash University)
16:25 Wed 4 December 2019 – G56
Daniel Horsley, Adam Mammoliti

The cyclic matching sequenceability of a graph G is the largest integer s such that there exists a sequence of the edges of G so that every s cyclically consecutive edges form a matching. The cyclic matching sequenceability is known for several special types of graphs but little is known in general about large classes of graphs.

In this talk I will present several results concerning cyclic matching sequenceability of general graphs and more specialised results for regular graphs. In particular, I will present upper and lower bounds of the cyclic matching sequenceability of general graphs. Finally, I will present results on the minimum cyclic matching sequenceability of 2-regular graphs and lower and upper bounds on the minimum cyclic matching sequenceability of k-regular graphs for $k \geq 3$. This is joint work with Daniel Horsley

5.20. The Cheeger constant for distance-regular graphs.

Greg Markowsky (Monash University)

13:55 Fri 6 December 2019 – G56

Dr Greg Markowsky

The Cheeger constant of a graph is the smallest possible ratio between the size of a subgraph and the size of its boundary. It is well known that this constant must be at least $\lambda_1/2$, where λ_1 is the smallest positive eigenvalue of the Laplacian matrix. In this talk I will discuss the conjecture that for distance-regular graphs the Cheeger constant is at most λ_1. The conjecture has been proved for most of the known infinite families of distance-regular graphs, for distance-regular graphs of diameter 2 (the strongly regular graphs), for several classes of distance-regular graphs of diameter 3, and for most distance-regular graphs with small valency. A number of cases remain open. Joint work with Jacobus Koolen and Zhi Qiao.

5.21. Geometric hypergraph colouring problems

Michael Payne (La Trobe University)

16:00 Wed 4 December 2019 – G56

Dr Michael Payne

Given a set of points in the plane, and a family of shapes, one can define a k-uniform hypergraph whose hyperedges are sets of k points contained in one of the shapes. This general procedure gives rise to a wide variety of interesting classes of hypergraph, including well studied graph classes such as planar graphs and Delaunay triangulations.

In this talk we will discuss colouring problems related to some such hypergraph classes, with a particular focus on hypergraphs with poset dimension at most three. In the right light, these can be seen as a natural generalisation of planar graphs.

5.22. Minkowski decompositions of polytopes via geometric graphs

Guillermo Pineda-Villavicencio (Deakin University)

15:35 Wed 4 December 2019 – G56

Dr Guillermo Pineda-Villavicencio

Minkowski decomposition of polytopes is presented via geometric graphs. This is due to Kallay (1982), who reduced the decomposability of a realisation of polytope to that of its geometric graph, and in this way, introduced the decomposability of geometric graphs. One advantage of this approach is its versatility. The decomposability of polytopes reduces to the decomposability of geometric graphs, which are not necessarily polytopal. And statements on decomposability of geometric graphs often revolve around the existence of suitable subgraphs or useful properties in the graphs.

As applications, we revisit many of the known results in this area, including the classifications into decomposable and decomposable, of d-polytopes with at most 2d vertices due to Kallay (1979), and of d-polytopes with 2d+1 vertices due to Pineda-Villacicencio et al (2018). We will also present a 3-polytope with both a decomposable realisation and an indecomposable realisation, showing in the strongest possible way that decomposability is not a combinatorial property.

The talk concludes with the main open problems in the area.

5.23. Middle Product Learning With Errors

Amin Sakzad (Monash University)

13:30 Thu 5 December 2019 – G56

Dr Amin Sakzad

We introduce a new variant MP-LWE of the Learning With Errors problem (LWE) making use of the Middle Product between polynomials modulo an integer q. We exhibit a reduction from the Polynomial-LWE problem (PLWE) parametrized by a polynomial f, to MP-LWE which is defined independently of any such f. The reduction only requires f to be monic with constant coefficient coprime with q. It incurs a noise growth proportional to the so-called expansion factor of f. We also describe a public-key encryption scheme with quasi-optimal asymptotic efficiency (the bit-sizes of the keys and the run-times of all involved algorithms are quasi-linear in the security parameter), which is secure against chosen plaintext attacks under the MP-LWE hardness assumption. The scheme is hence secure under the assumption that PLWE is hard for at least one polynomial f of degree n among a family of f's which is exponential in n.

5.24. Counting automorphisms of random trees with martingales

Angus Southwell (Monash University)

16:50 Tue 3 December 2019 – G56

Mr Angus Southwell

Yu (*Automorphisms of random trees*, PhD thesis, 2012) conjectured that the distribution of the number of automorphisms of a random labelled tree is asymptotically lognormal. We prove this conjecture using a new general martingale approach for properties of random labelled trees. To apply our theory, we show that the logarithm of the number of automorphisms is stable with respect to small perturbations. In this talk I give the central limit theorem for general tree parameters and then demonstrate how to apply it to this problem.

5.25. Some examples of nonnormal Cayley graphs on nonabelian simple groups

Binzhou Xia (The University of Melbourne)

14:20 Fri 6 December 2019 – G56
Dr Binzhou Xia

A Cayley graph on a group G is said to be nonnormal if the right multiplication action of G on itself induces a non-normal subgroup of the full automorphism group of the Cayley graph. Nonnormal Cayley graphs are believed to be rare among all the Cayley graphs. In this talk, I will present some infinite families of nonnormal Cayley graphs on nonabelian simple groups, whose existence was asked in the literature.

5.26. Bounded Difference Inequalities for Graph-Dependent Random Variables

Rui Zhang (Monash University)

16:00 Tue 3 December 2019 – G56
Mr Rui Zhang

We establish exponential concentration bounds for Lipschitz functions of dependent random variables, whose dependencies are specified by dependency graphs. The proof is based on Cramér-Chernoff method using martingales and coupling. These are extensions of McDiarmid's bounded difference inequality to the dependent cases. We also provide applications and examples in statistics and machine learning.

5.27. The vertex-isoperimetric number of the incidence graphs of unitals and finite projective spaces

Sanming Zhou (The University of Melbourne)

13:30 Fri 6 December 2019 – G56
Prof Sanming Zhou

A fundamental problem in graph theory is to understand various expansion properties of graphs. The expansion of a graph is commonly measured by its isoperimetric number (also known as Cheeger constant) or its vertex-isoperimetric number. I will talk about some recent results on the vertex-isoperimetric number of the incidence graph of unitals and the point-hyperplane incidence graph of $PG(n,q)$, where a unital is a 2-$(n^3+1, n+1, 1)$ design for some integer $n \geq 2$.

Joint work with Andrew Elvey-Price, Alice M. W. Hui and Muhammad Adib Surani.

6. Computational Mathematics

6.1. Bragg Edge Neutron Transmission Strain Tomography using the Finite Element Method

Riya Aggarwal (The University of Newcastle)

16:50 Wed 4 December 2019 – 189

Ms Riya Aggarwal

Bragg edge strain imaging from energy-resolved neutron transmission measurements poses an interesting tomography problem. The solution to this problem will allow the reconstruction of detailed stress and strain distributions within polycrystalline solids from sets of Bragg edge strain images. In the proposed method, we provide a general approach to reconstruction of an arbitrary system based on a finite element approach with least-squares process constrained by equilibrium. This approach has developed in two dimensions before being demonstrated experimentally on the samples using the RADEN instrument at the J-PARC spallation neutron source in Japan. Validation of the resulting reconstructions has provided through a comparison to conventional constant wavelength strain measurements carried out on the KOWARI engineering diffractometer within ANSTO in Australia.

6.2. Uncertainty Quantification for the Linear Elastic equations

Michael Clarke (UNSW Sydney)

16:00 Wed 4 December 2019 – 189

Mr Michael Clarke

The notion of assigning random fields to parameters in PDE's in order to compute a quantity of interest, namely a functional of the solution, has been investigated rigorously for uniform distributions and subsequently the log-normal case. The body of work thus far has considered elliptic PDE's of the same type as the diffusion equation and a generalisation to affine parametric operator equations, both of which were restricted to one random field input. We have sought to extend these methodologies to Navier's equations of linear elasticity which contain two elastic moduli (Lamé parameters) as random field expansions. The computation of an expectation value of the solution is approached using a Quasi-Monte Carlo (QMC) quadrature rule, motivated by the higher order convergence $O(N^{-\frac{1}{p}})$ achieved for deterministic interlaced polynomial lattice point sets, where p is a smoothness parameter related to the integrand function, and the computational cost is reduced by using a Sparse Grid truncation. We provide a priori estimates and regularity results in the natural Sobolev space setting, accounting for each source of numerical error, and we compare the numerical results with these theoretical estimates. Furthermore we outline ongoing work, informed by the Multi-Level QMC rule, whereby the aim is to minimise the computational cost required to achieve a fixed error bound and, in doing so, we treat each discretisation parameter for the numerical problem as an index set on an extended Sparse Grid.

This work has been undertaken jointly with Josef Dick, Quoc Thong Le Gia and Bishnu Lamichhane.

6.3. High-order numerical schemes for degenerate elliptic equations

Jerome Droniou (Monash University)

13:55 Thu 5 December 2019 – 189

A/Prof. Jerome Droniou, Prof. Robert Eymard

The Stefan equation is a well-known degenerate parabolic equation that models the evolution of a material that transitions from one phase to another. It is written

$$\partial_t u - \Delta\zeta(u) = f$$

(with appropriate initial and boundary conditions), where $\zeta : \mathbf{R} \to \mathbf{R}$ is non-decreasing but can have plateaux. Here, u represents the energy of the material and $\zeta(u)$ its temperature, and the plateaux of ζ represents the well-known situation where the material receives energy that enables a phase transition without increase of temperature (think of boiling water, which remains at 100 degrees while it is boiling).

When using an implicit time-stepping scheme (e.g. Euler or, more generally, discontinuous Galerkin in time), one ends up having to discretise in space the following stationnary version of this model:

$$(\star) \qquad u - \Delta\zeta(u) = f.$$

Because of the plateaux of ζ, this equation is a *degenerate* elliptic equation, which looses its ellipticity when u reaches values corresponding to a plateau of ζ. Due to this change of nature, designing stable numerical schemes for ($\star$) is tricky, even more so when one seeks very accurate approximations – namely, high-order numerical methods.

In this talk, after briefly highlighting the main principles for finding a stable scheme for ($\star$), we will explain how high-order numerical approximations of this equation can be designed. The stability relies on a proper notion of mass-lumping, which uses piecewise constant approximations. This choice seems in first instance incompatible with a high-order approximation, but we will identify conditions on the cell-wise quadrature rules that ensure an elevated accuracy of the scheme. Appropriate quadrature rules can be designed in 1D and on triangular meshes in 2D, and we will present various numerical results obtained by $\mathbf{P}_k$ finite elements and discontinuous galerkin methods.

6.4. Unfitted Nitsche's method for computing edge modes in photonic graphene

Hailong Guo (The University of Melbourne)

14:45 Wed 4 December 2019 – 189

Dr Hailong Guo

Photonic graphene, a photonic crystal with honeycomb structures, has been intensively studied in both theoretical and applied fields. Similar to graphene which admits Dirac Fermions and topological edge states, photonic graphene supports novel and subtle propagat- ing modes (edge modes) of electromagnetic waves. These modes have wide applications in many optical systems. In this paper, we propose a new unfitted Nitsche's method to computing edge modes in photonic graphene with some defect. The unique feather of the methods is that it can arbitrary handle high contrast with geometric unfitted meshes. We establish the optimal convergence of meth- ods. Numerical examples are presented to validate the theoretical results and to numerically verify the existence of the edge modes.

6.5. Approximating functions of the precision matrix of Gaussian processes

Markus Hegland (Australian National University)

13:30 Wed 4 December 2019 – 189

Prof Markus Hegland

We are considering the approximation of functions of covariance or precision matrices of Gaussian processes. We are working on a new approach which uses Chebyshev polynomials and a Moebius transform which maps the spectrum of the precision matrix onto the interval $(0,1)$. We have implemented the approach and will report on some tests for matrices from a paper by Pettit, Weir and Hart. We use Python, Chebfun and spatial indexing based on a kd-tree from Scipy's spatial algorithms and data structures package to generate large and sparse precision matrices.

This is joint work with Prof. Ian Turner, QUT.

6.6. Probabilistic Saturations and Alt's Problem in Mechanism Design

Martin Helmer (Australian National University)

18:05 Wed 4 December 2019 – 189

Dr Martin Helmer

Alt's problem formulated in 1923 is to count the number of four-bar linkages whose coupler curve interpolates nine general points in the plane. This problem can be formulated as counting the number of solutions to a system of polynomial equations which was first solved numerically using homotopy continuation by Wampler, Morgan, and Sommese in 1992.

Since there is still not a proof that all solutions were obtained, we consider upper bounds for Alt's problem by counting the number of solutions outside of the base locus to a system arising as the general linear combination of polynomials. In particular, we derive effective symbolic and numeric methods for studying such systems using probabilistic saturations that can be employed using both finite fields and floating-point computations.

The methods are probabilistic and we give bounds on the size of finite field required to achieve a desired level of certainty. Both theoretical and computational results and methods will be discussed.

This talk is based on joint work with Jonathan Hauenstein (University of Notre Dame).

6.7. Parallel time integration of hyperbolic PDEs

Oliver krzysik (Monash University)

15:35 Wed 4 December 2019 – 189

Mr Oliver krzysik

Parallel-in-time methods, such as multigrid reduction-in-time (MGRIT) and Parareal, provide an attractive option for increasing concurrency when simulating time-dependent PDEs in modern high-performance computing environments. While these techniques have been very successful for diffusion-dominated equations, it has often been observed that their performance suffers dramatically when applied to advection-dominated problems or purely hyperbolic PDEs. In this talk, I will give a brief introduction to these algorithms and show examples of the aforementioned behaviour. I show that this degradation can be understood from existing convergence theory of these solvers, and I consider designing their components though approximately maximising convergence-rate estimates. Finally, for the canonical hyperbolic PDE of constant-coefficient linear advection, I show for the first time that fast and scalable parallel time integration is possible, achieving convergence in just a handful of iterations, even for high-order-accurate discretizations.

6.8. A multiscale radial basis function method for severely ill-posed problems on spheres

Quoc Thong Le Gia (University of New South Wales)

14:20 Thu 5 December 2019 – 189

Dr Quoc Thong Le Gia

We propose and analyse the support vector approach to approximating the solution of a severely ill-posed problem $Au = f$ on the sphere, in which A is an ill-posed map from the unit sphere to a concentric larger sphere. The Vapnik's ε-intensive function is adopted in the regularisation technique to reduce the error induced by noisy data. The method is then extended to a multiscale algorithm by varying the support radius of the radial basis functions at each scale. We discuss the convergence of the multiscale support vector approach and provide strategies for choosing both regularisation parameters and cut-off parameters at each level. Numerical examples are constructed to verify the efficiency of the multiscale support vector approach.

This is a joint work with Ian Sloan (UNSW) and Min Zhong (Southeast University, China).

6.9. The Virtual Element Method for solving partial differential equations on unstructured polytopal meshes

Gianmarco Manzini (Consiglio Nazionale delle Ricerche (CNR) - Italy)

13:55 Wed 4 December 2019 – 189
Dr Gianmarco Manzini

In this talk, we first review some ideas concerning numerical methods for solving Partial Differential Equations (PDEs) of elliptic and parabolic type on a computational domain that is partitioned by unstructured meshes admitting elements with very general geometric shapes. Then, we present the Virtual Element Method (VEM), which is a very special kind of Finite Element Method (FEM) that does not require explicit knowledge of the basis functions in the discretization. In fact, the VEM makes systematic use of projections onto polynomials subspaces in the construction of the discrete bilinear forms used in the weak formulations. A suitable choice of the degrees of freedom allows these polynomial projections to be computable even if the projected function is unknown. The VEM has different formulations as the FEM (conforming, nonconforming, mixed, etc), and the fact that basis functions must not be explicitly computed makes the method extremely flexible in applications. We terminate the talk by showing numerical results to illustrate the accuracy and the robustness of the method.

6.10. Pressure Buildup in Surtseyan Ejecta

Mark Joseph McGuinness (Victoria University of Wellington)

17:15 Wed 4 December 2019 – 189
Mark McGuinness, Emma Greenbank

A Surtseyan eruption is a particular kind of volcanic eruption which involves the bulk interaction of water and hot magma, mediated by the return of ejected ash. Surtsey Island, off the coast of Iceland, was born during such an eruption process in the 1940s. Mount Ruapehu in New Zealand has also featured Surtseyan eruptions, due to its crater lake.

One feature of such eruptions is ejected lava bombs, trailing steam, with evidence that watery slurry was trapped inside them during the ejection process. Simple calculations indicate that the pressures developed inside such a bomb should shatter it. Yet intact bombs are routinely discovered in debris piles. In an attempt to crack this problem, I will talk about a transient mathematical model of the flashing of water to steam inside one of these hot erupted lava balls, with a particular focus on the maximum pressure developed and how it depends on the magma properties.

6.11. A stable finite volume scheme for nonlinear diffusion equations on general 2D meshes

El Houssaine QUENJEL (Nice Sophia Antipolis University)

16:25 Wed 4 December 2019 – 189
Dr El Houssaine QUENJEL

Diffusion problems arise in many complex applications such as geothermal systems, soil remediation and chemotaxis models. The discretization of diffusion terms thanks to stable and consistent finite volume methods on distorted grids is a challenging task. In my talk I will present a simple idea on how to build such a finite volume scheme that preserves the physics of the problem at the discrete level, namely the positivity of the approximate solution and the decay of the free energy for large times. These properties are rigorously proved in the framework of the discrete duality finite volume methods. Numerical tests are given to illustrate the ability of the proposed approach to deal with sever meshes while keeping its efficiency and robustness.

6.12. An approach to electrical impedance tomography in unknown domains

Janosch Rieger (Monash University)

17:40 Wed 4 December 2019 – 189
Prof Bastian Harrach, Dr Janosch Rieger

Elliptical impedance tomography is a non-invasive imaging technology. In contrast to computerised tomography, it is not based on x-ray pictures, but on measurements of the electrical potential of the imaged body. The reconstruction of the conductivity inside the body, and hence its internal structure, from boundary measurements is a nonlinear ill-posed problem, and hence challenging from a computational perspective, even when the exact shape of the body is known. We propose a new method for the local reconstruction of conductivity anomalies from boundary measurements that seems to work even for bodies with completely unknown geometry. The price we pay is that we compute an approximation of the so-called convex source support of the measurement instead of the actual anomaly.

6.13. A posteriori error estimation for nonlinear elliptic equations

Thanh Tran (University of New South Wales)

13:30 Thu 5 December 2019 – 189
Thanh Tran

We propose an a posteriori error estimation technique for the finite element solution of the steady-state nonlinear reaction-diffusion equation on a rectangular domain in two dimensions. Our a posteriori error estimation scheme is an implicit method and is based on the element residual method. Error estimates are computed locally on each element as the solution of a 2×2 linear system, which is simple and cheap to solve. We prove that the proposed error estimates are asymptotically correct.

This is a joint work with Kenny Lau.

7. Dynamical Systems and Ergodic Theory

7.1. Conformal and Invariant Measures for Random Covering Weighted Systems

Jason Atnip (University of New South Wales)

16:50 Wed 4 December 2019 – 123
Jason Atnip

We consider random, countable branch piecewise monotonic maps of the interval. We show the existence of unique conformal and invariant measures under the assumptions of random covering and a contracting potential. We also show that the system is exponentially mixing with respect to the invariant measure. This is all accomplished via random cone techniques and transfer operator methods.

7.2. On the number of ergodic absolutely continuous invariant measures for higher dimensional random dynamical systems

Fawwaz Batayneh (University of Queensland)

17:15 Wed 4 December 2019 – 123
Mr Fawwaz Batayneh

An admissible random Jablonski map is a non autonomous dynamical system such that at each time ω, the dynamical system is described by a Piecewise C^2 and monotonic Jablonski map f_ω chosen from a collection $f = \{f_\omega : I^N \circlearrowleft\}_{\omega\in\Omega}$ which satisfies an on average expanding condition. At each time ω, the way of selecting the map f_ω comes from the so called base map σ defined on a probability space $(\Omega, \mathscr{F}, \mathbb{P})$ which is assumed to be invertible, ergodic and $\mathbb{P}-$preserving map.

The concept of sample measures in the random case is the natural generalization of the notion of invariant measure in the case of deterministic dynamical systems. Sample measures for random compositions of expanding interval maps have previously been studied by Pelikan, Morita and in a more general setting by Buzzi. The author considered random compositions of Lasota-Yorke maps and proved that the associated skew product transformation admits a finite number of ergodic absolutely continuous invariant measures and provided an upper bound that controls the number of these measures.

In the setting of a random compositions of Jablonski maps, we have proved that admissible random Jablonski maps are quasi compact and their associated skew product admits a finite number of ergodic random absolutely continuous invariant measures. This talk will focus on providing upper bounds for this number.

7.3. A spectral approach for quenched limit theorems for random dynamical systems

Gary Froyland (University of New South Wales)

16:25 Wed 4 December 2019 – 123
Prof Gary Froyland

After a gentle introduction to statistical limit laws, I will discuss quenched (i.e. "realisation-wise") versions of (i) a large deviations principle, (ii) a central limit theorem, and (iii) a local central limit theorem for non-autonomous dynamical systems. A key advance is the extension of the spectral method, commonly used in limit laws for deterministic maps, to the general random setting. We achieve this via multiplicative ergodic theory and the development of a general framework to control the regularity of Lyapunov exponents of twisted transfer operator cocycles with respect to a twist parameter. An important aspect of our results is that we only assume ergodicity and invertibility of the random driving; in particular no expansivity or mixing properties are required. This is joint work with D. Dragicevic, C. González-Tokman, and S. Vaienti.

7.4. On the Dynamics of Inverse Magnetic Billiards

Sean Gasiorek (The University of Sydney)

14:20 Thu 5 December 2019 – 123
Dr Sean Gasiorek

Consider a strictly convex set Ω in the plane, and a homogeneous, stationary magnetic field orthogonal to the plane whose strength is B on the complement of Ω and 0 inside Ω. The trajectories of a charged particle in this setting are straight lines concatenated with circular arcs of Larmor radius μ. We examine the dynamics of such a particle and call this *inverse magnetic billiards*. Comparisons are made to standard Birkhoff billiards and magnetic billiards, as some theorems regarding inverse magnetic billiards are consistent with each of these billiard variants while others are not.

7.5. Characterization and perturbations of the Lyapunov spectrum of a class of Perron-Frobenius operator cocycles

Cecilia Gonzalez-Tokman (The University of Queensland)

17:40 Wed 4 December 2019 – 123
Dr Cecilia Gonzalez-Tokman

The Lyapunov spectrum of Perron-Frobenius operator cocycles contains relevant information about dynamical properties of time-dependent (non-autonomous, random) dynamical systems. In this talk we characterize the Lyapunov spectrum of a class of analytic expanding maps of the circle, and discuss stability and instability properties of this spectrum under perturbations. (Joint work with Anthony Quas.)

7.6. Multiscale modelling enables prediction and simulation of floods and tsunamis

Divahar Jayaraman (The University of Adelaide)

13:55 Wed 4 December 2019 – 123

J. Divahar

Floods and tsunamis are challenging to predict. Prediction (is a tsunami/flood on its way?) and simulation (which areas would be affected?) would save lives and assets. We primarily need to simulate water height and velocity variations over many kilometres (macroscale characteristics), but the cause and manifestation of such kilometre-scale effects happen at the sub-metre-scale (microscale). Hence we cannot neglect the complex sub-metre-scale physics, at the same time detailed simulation over many kilometres is impractical. Our research aims to accurately model the macroscale characteristics of such complex waves by a detailed microscale simulation only in a small fraction (about 0.01%) of the whole space. Patch dynamics multi-scale method performs detailed microscale simulations within small patches across the whole space and couples the patches by interpolating their boundary values in macroscale. We are developing few classes of multi-scale methods (patch sche mes) generalising patch dynamics to accurately model complex waves over large space. For representative simple nonlinear waves with linear drag and viscous diffusion, we find that the large waves in the patch scheme simulation match exactly (within numerical round-off errors) with the detailed microscale simulation over whole space. This assures that the patch schemes from the simulation over a small fraction of the whole space, successfully capture exactly, the corresponding macroscale characteristics in the time evolution of waves. Thus, the developing patch schemes capture macroscale wave physics as accurately as the detailed microscale simulation, with large computational savings by several thousand times. Currently we are extending to more complex nonlinear viscous waves. Next we will extend to include turbulence which will enable accurate simulation of real world floods and tsunamis over large space.

7.7. Blowing-up essential singularities in singularly perturbed problems

Sam Jelbart (The University of Sydney)

14:45 Wed 4 December 2019 – 123

Mr Sam Jelbart

Many dynamical systems feature essential singularities due to terms of the form $e^{-h(x)/\epsilon}$, $\epsilon \to 0$. The presence of such terms leads naturally to qualitatively distinct dynamics depending on the sign of $h(x)$, and consequently to the presence of sharp transitionary regions near $h(x) = 0$ when $0 < \epsilon \ll 1$. Problems with sharp transitions are frequently understood using a combination of (geometric) singular perturbation theory and geometric desingularisation ('blow-up') techniques. The usual methods, however, are not directly applicable to essential singularities.

In this talk, we consider a model of transistor oscillations featuring an essential singularity of the kind described above. In the context of this problem, we describe an extension for the traditional methods for geometric desingularisation which make the analysis possible, allowing for a geometric proof of the existence and uniqueness of the oscillations. Via this analysis, we hope to make the case that the methods adopted have a more general applicability.

7.8. On Sil'nikov saddle-focus homoclinic orbits

Kenneth James Palmer (National Taiwan University)

13:30 Thu 5 December 2019 – 123

Prof Kenneth James Palmer

Sil'nikov showed that that there is chaos in the neighbourhood of a saddle focus homoclinic orbit.This talk reviews joint work of the speaker with Flaviano Battelli, Brian Coomes and Huseyin Koçak on these orbits. First an example due to Rodrigues of such an orbit in three dimensions is reviewed. This example is found by perturbing a system which is degenerate in some sense. Other examples in three dimensions have been found from numerical simulations. It is shown how rigorous numerics can be used to prove that these examples are valid. Sil'nikov originally considered these orbits in 3 dimensions but later he extended his theory to higher dimensions. For these orbits it is necessary to verify three further conditions. Originally these conditions were geometric in nature but they are in fact equivalent to conditions on bounded solutions of the variational equation along the homoclinic orbit. These conditions are more easily verifiable and are used to construct of an orbit in 4 dimensions by again perturbing a degenerate system. A rigorous numerical method is also given for verifying that a homoclinic orbit (in higher dimensions) found by numerical simulations does in fact exist and satisfies all of Sil'nikov's conditions.

7.9. Application of local attractor dimension to reduced space strongly coupled data assimilation for chaotic multiscale systems

Courtney Rose Quinn (CSIRO)

14:20 Wed 4 December 2019 – 123

Dr Courtney Rose Quinn

The basis and challenge of strongly coupled data assimilation (CDA) is the accurate representation of cross-domain covariances between various coupled subsystems with disparate spatio-temporal scales, where often one or more subsystems are unobserved. In this study, we explore strong CDA using ensemble Kalman filtering methods applied to a conceptual multiscale chaotic model consisting of three coupled Lorenz attractors. We introduce the use of the local attractor dimension (i.e. the Kaplan-Yorke dimension, $\dim_{KY}$) to determine the rank of the background covariance matrix which we construct using a variable number of weighted covariant Lyapunov vectors (CLVs). Specifically, we consider the ability to track the nonlinear trajectory of each of the subsystems with different variants of sparse observations, relying only on the cross-domain covariance to determine an accurate analysis for tracking the trajectory of the unobserved subdomain. We find that spanning the global unstable and neutral subspaces is not sufficient at times where the nonlinear dynamics and intermittent linear error growth along a stable direction combine. At such times a subset of the local stable subspace is also needed to be represented in the ensemble. In this regard the local $\dim_{KY}$ provides an accurate estimate of the required rank. Additionally, we show that spanning the full space does not improve performance significantly relative to spanning only the subspace determined by the local dimension. Where weak coupling between subsystems leads to covariance collapse in one or more of the unobserved subsystems, we apply a novel modified Kalman gain where the background covariances are scaled by their Frobenius norm. This modified gain increases the magnitude of the innovations and the effective dimension of the unobserved domains relative to the strength of the coupling and time-scale separation. We conclude with a discussion on the implications for higher dimensional systems.

7.10. A geometric proof of Ratner's mixing rates for the horocycle flow

Davide Ravotti (Monash University)
13:55 Thu 5 December 2019 – 123
Dr Davide Ravotti

For several parabolic systems, a technique often used to prove mixing and other strong chaotic properties consists of a geometric shearing argument. In the case of the horocycle flow (both in constant and in variable negative curvature, as well as for its time-changes), this has been done successfully by analysing the action of the horocycle flow on geodesic arcs. The quantitative estimates one can obtain following this approach, however, are not optimal, since, in the constant curvature case, do not match the ones obtained by Ratner. We will prove an effective equidistribution result for the horocycle push-forward of homogeneous arcs transverse to the weak-stable leaves of the geodesic flow. As a corollary, we derive a geometric proof of Ratner's quantitative mixing result for the horocycle flow.

7.11. An empirical stability analysis of restricted Four-Body model

Anoop Sivasankaran (Khalifa University of Science, Technology)
13:30 Wed 4 December 2019 – 123
Dr Anoop Sivasankaran

Recently we have developed a global regularization scheme that consists of adapted versions of several known regularisation transformations which removes all the singularities due to colliding pairs of masses. An algebraic optimisation algorithm is also developed for numerically implementing the regularisation scheme which make use of the reverse mode algorithmic differentiation. We use this new developed method to empirically analyse the stability of a symmetrically restricted four body problem by studying the hierarchical evolution of a comprehensive set of orbits appearing in the phase space.

7.12. Model reduction for the collective dynamics of networks of coupled oscillators

Lachlan Smith (The University of Sydney)
16:00 Wed 4 December 2019 – 123
Dr Lachlan Smith

Many natural phenomena and industry applications can be modelled as networks of coupled oscillators, including firefly flashing, neuron firing, and power grid dynamics. A common phenomenon in networks of coupled oscillators is synchronisation. Model reduction techniques aim to understand and quantify this low-dimensional emergent macroscopic dynamics. In this talk I will present the collective coordinate approach to model reduction for networks of coupled oscillators, and compare the collective coordinate approach with the widely used Ott-Antonsen approach. I will show that the collective coordinate approach yields a more accurate approximation for the macroscopic dynamics of finite networks of coupled oscillators than the Ott-Antonsen approach, and recovers well-known results in the thermodynamic limit of infinitely many oscillators.

8. Financial mathematics

8.1. Modelling additional information: filtration enlarged via a marked random time

Anna Aksamit (The University of Sydney)

13:55 Thu 5 December 2019 – 182

Dr Anna Aksamit

We consider enlargement of a reference filtration through the observation of a random time and a mark. Random time considered is such that its graph is included in the countable union of graphs of stopping times. Mark revealed at this random time is assumed to satisfied generalised Jacod's condition. Classical Jacod's condition concerns initial enlargements and says that the conditional law of a random variable w.r.t. elements of a reference filtration is absolutely continuous w.r.t. its unconditional law. Our relaxation of Jacod's condition accounts for the dynamic structure of the problem. In this set-up we study classical filtration enlargements questions such as semimartingale decomposition. This framework allows up to recover initial enlargement under Jacod's condition as well as progressive enlargement with a thin random time.

8.2. Convex duality in robust hedging and optimal stopping problems

Ivan Guo (Monash University)

13:55 Wed 4 December 2019 – 182

Dr Ivan Guo

We introduce a generalisation of the classical martingale optimal transport problem that relaxes the usual marginal distribution constraints to arbitrary path-dependent constraints on the space of probability measures. Strong convex duality is established, which directly leads to a path-dependent Hamilton-Jacobi-Bellman equation in which the solution localises to the state variables of the constraints, while bypassing the usual dynamic programming principle.

We then show how various pricing-hedging duality results in robust hedging and optimal stopping can be inferred from our convex duality result. Moreover, by combining it with extremal point arguments on the space of measures on stopped paths, we discuss how this technique can be applied to the problem of robust hedging American options in continuous time.

8.3. Vulnerable American Contracts with Extraneous Risks and Market Frictions

Edward Kim (The University of Sydney)

17:15 Wed 4 December 2019 – 182

Mr Edward Kim

We formulate the problem of valuing American-type contracts under two non-standard features: (1) There is an extraneous non-hedgeable event. When the event occurs, the contract is terminated and a recovery payoff is paid instead of the contracted payoff profile. (2) There are trading frictions (e.g. diverging borrowing and lending rates, collateral obligations under the contract financed by the portfolio) so that the dynamics of self-financing portfolios are no longer linear. As we use an arbitrage approach to valuation, we propose definitions of "arbitrage" and "superhedging the claim". Under certain market conditions, the problem can be characterised as a nonlinear optimal stopping problem, or the solution of a reflected backward stochastic differential equation.

8.4. Mean-field stable CIR process

Libo Li (University of New South Wales)

13:30 Thu 5 December 2019 – 182

Libo Li

We study the strong well-posedness as well as the numerical approximation of a one-dimensional stable driven stochastic differential equation with mean field interaction in the drift. The work is motivated by the study of contagion behaviors in default and interest rates modelling.

8.5. Non-Markovian Multidimensional Quadratic BSDE

Kihun Nam (Monash University)

14:20 Wed 4 December 2019 – 182

Dr Kihun Nam

Xing and Zitkovic (2018) recently proved the existence and uniqueness of solution for a system of quadratic backward stochastic differential equations (BSDE) under Markovian set-up using PDE. The driver of the system is assumed to satisfy the Bensoussan–Frehse (BF) condition. The solution of such a system corresponds to the Nash equilibrium in stochastic differential game or price impact model. In this talk, based on probabilistic argument, we will present the existence and uniqueness result under the non-Markovian setting with BF condition.

8.6. Portfolio optimization with a prescribed terminal wealth density by deep optimal transport

WEI Ning (Monash University)

13:30 Wed 4 December 2019 – 182

Miss WEI Ning

This paper aims at steering the portfolio wealth from an initial distribution to a prescribed distribution at the terminal time, via controlling the portfolio allocation process. We study this problem under the framework of Optimal Mass Transport, and we provide a duality result for it. Numerically, we solve the dual problem by seeking for the optimal potential function with a finite difference method, and we directly solve for the allocation process in the primal problem with a deep learning method. Then numerical examples for various target terminal distributions are given, showing that we can successfully reach the attainable targets.

8.7. Robust finance: data-driven approach to pricing, hedging and risk management

Jan Obloj (University of Oxford)

15:35 Wed 4 December 2019 – 182

Prof Jan Obloj

How do we quantify the impact of making assumptions? How do we value information (data)? How do we capture the interplay between risk (described by a familiar model) and uncertainty (about the model itself)? In this talk I introduce the robust paradigm which strives to answer such questions. The framework is designed to interpolate between model-independent and model-specific settings and to allow to address and quantify the model risk. I explain briefly how classical fundamental notions and theorems in quantitative finance extend to the robust setting. I then focus on simple concrete examples. I use vanilla option prices, together with agent-prescribed bounds on key market characteristics, to drive the interval of no-arbitrage prices and the associated hedging strategies. The setting can be seen as a constrained variant of the classical optimal transportation problem and comes with a natural pricing-hedging duality. I discuss numerical methods based on discretisation and LP implementation but subsequently focus on a deep NN optimisation. Finally, I look at ways to coherently combine option prices data with past time series data, leading to a dynamic robust risk estimation. I explain how such non-parametric statistical estimators of key quantities (e.g., superhedging prices, 10-days V@R) superimposed with option prices can be treated as information signals.

8.8. Path Independence of Exotic Options and Convergence of Binomial Approximations

Kenneth James Palmer (National Taiwan University)

14:45 Wed 4 December 2019 – 182

Prof Kenneth James Palmer

This is joint work with Guillaume Leduc. We present ways in which barrier and lookback options can be regarded, in some sense, as path-independent options. For both kinds of options, the usual binomial approach yields convergence of order $n^{-1/2}$, where n is the number of periods, but our path-independent pricing yields convergence of order $1/n$.

8.9. Calibration of Local-Stochastic Volatility models by Optimal Transport

Shiyi Wang (Monash University)

16:25 Wed 4 December 2019 – 182

Ivan Guo, Gregoire Loeper, Shiyi Wang

In this paper, we study a semi-martingale optimal transport problem and its application to the calibration of Local-Stochastic Volatility (LSV) models. Rather than considering the classical constraints on marginal distributions at initial and final time, we optimise our cost function given the prices of a finite number of European options. We formulate the problem as a convex optimisation problem, for which we provide a dual formulation. Then we solve numerically the dual problem, which involves a fully non-linear Hamilton-Jacobi-Bellman equation. The method is tested by calibrating a Heston-like LSV model with simulated data and foreign exchange market data.

8.10. Multiscale Linear-Quadratic Stochastic Optimal Control

James Yang (The University of Sydney)

16:50 Wed 4 December 2019 – 182

Mr James Yang

In this talk, we consider a quadratic optimisation problem driven by a multiscale linear stochastic differential equation with multiplicative noise. Such problems are motivated by models with slow-fast dynamics and reducing the dimensional complexity. In particular, interesting observations can be made by considering the convergence problem as the speed of the slow and fast dynamics diverge. This can be done by applying singular perturbation theory to the differential Riccati equation. As a result, we are able to construct approximating optimal controls and value function, which are of a lower dimensional complexity. Finally, we discuss the optimal control problem when the noise is additive. In this case, we can show that the approximate value function is composed of value functions from two subproblems; another linear-quadratic optimisation problem and an ergodic control problem. This is a joint work with Ben Goldys (USyd), Gianmario Tessitore (Uni of Milano-Bicocca) and Zhou Zhou (USyd).

8.11. On the Notions of Equilibria for Time-inconsistent Stopping Problems in Continuous Time

Zhou Zhou (The University of Sydney)

14:20 Thu 5 December 2019 – 182

Erhan Bayraktar, Jingjie Zhang, Zhou Zhou

A new notion of equilibrium, which we call strong equilibrium, is introduced for time-inconsistent stopping problems in continuous time. Compared to the existing notions introduced in [Huang &

Nguyen-Hu, 2018] and [Christensen & Lindensjo, 2018], which in this paper are called mild equilibrium and weak equilibrium respectively, a strong equilibrium captures the idea of subgame perfect Nash equilibrium more accurately. When the state process is a continuous-time Markov chain and the discount function is log sub-additive, we show that an optimal mild equilibrium is always a strong equilibrium. Moreover, we provide a new iteration method that can directly construct an optimal mild equilibrium and thus also prove its existence.

9. Functional Analysis, Operator Algebra, Non-commutative Geometry

9.1. Isomorphisms of $AC(\sigma)$ spaces.

Shaymaa Shawkat Kadhim Al-shakarchi (University of New South Wales)

16:00 Tue 3 December 2019 – 134

Mrs Shaymaa Shawkat Kadhim Al-shakarchi

A theorem of Gelfand and Kolmogoroff in 1939 asserts that, the compact spaces X and Y are homeomorphic if and only if the algebras of continuous functions $C(X)$ and $C(Y)$ are isomorphic as algebras. In 2005, the algebras of absolutely continuous functions $AC(\sigma)$ was defined by Doust and Ashton on a compact subset σ of the complex plane, and they studied whether there was a similar link for these algebras between the properties of the domain σ and the Banach algebra properties of the function space. In one direction Doust and Leinert (2015) showed that if $AC(\sigma_1)$ is algebra isomorphic to $AC(\sigma_2)$ then σ_1 and σ_2 must be homeomorphic, so the interest now is in examining the converse implication.

In general the answer is no. We have examples of infinite families of homeomorphic spaces σ_n for which the corresponding $AC(\sigma_n)$ spaces are mutually nonisomorphic. On the other hand, if one only considers sets σ lying in restricted families, then one can obtain positive results. Doust and Leinert showed that if the sets σ_1 and σ_2 are polygonal compact subsets of the plane then $AC(\sigma_1)$ is algebra isomorphic to $AC(\sigma_2)$. Then in our research we have continued addressing the Gelfand-Kolmogorff theorem in a class of functions spaces $AC(\sigma)$ by investigating the algebraic structure of functions on a different types of compact sets σ where σ is finite union of line segments and finite union of convex edges.

9.2. Higher twisted K-theory

David Leonard Brook (The University of Adelaide)

15:35 Tue 3 December 2019 – 134

Mr David Leonard Brook

Higher twisted K-theory is a recent generalisation of topological K-theory stimulated by results of Ulrich Pennig and Marius Dadarlat, who use an operator algebraic approach to provide geometric representatives for all abstract twists of K-theory. It involves a larger class of twists than Rosenberg's twisted K-theory - which has ties to string theory - and as such it is expected to be of physical interest in the realm of M-theory. In this talk, I will present an introduction to higher twisted K-theory and explain why this new construction is expected to yield meaningful results. In particular, I will outline computational techniques including the Mayer-Vietoris sequence and a twisted Atiyah-Hirzebruch spectral sequence, and present constructions of explicit geometric representatives for twists in special cases.

9.3. Some geometric constants for Morrey spaces

Hendra Gunawan (Bandung Institute of Technology)

13:30 Fri 6 December 2019 – 134

Prof Hendra Gunawan

In this talk we shall discuss three geometric constants, namely the von Neumann-Jordan constant, the James constant, and the Dunkl-Williams constant, for Morrey spaces. These constants measure uniformly non-squareness of the spaces. We shall see that the three constants are the same as those for L^1 and L^∞ spaces, which show that Morrey spaces are not uniformly non-square. The work is joint with E. Kikianty, Y. Sawano, and C. Schwanke.

9.4. The talented monoid of a directed graph

Roozbeh Hazrat (Western Sydney University)

13:55 Fri 6 December 2019 – 134

Prof Roozbeh Hazrat

We associate an abelian monoid to a direct graph. We show how this monoid beautifully captures the geometry of the graph! The hope is that this monoid would be a complete invariant for a class of algebra called Leavitt path algebras.

9.5. Fredholm Property of Operators from 2D String Field Theory

Hai-Long Her (The Australian National University)

15:10 Tue 3 December 2019 – 134

Prof Hai-Long Her

In a recent study of Landau-Ginzburg model of string field theory, there appears a type of perturbed Cauchy-Riemann equation, i.e. the zeta-instanton equation. Solutions of zeta-instanton equation have degenerate asymptotics. This degeneracy is a severe restriction for obtaining the Fredholm property and constructing relevant homology theory. In this article, we study the Fredholm property of a sort of differential operators with degenerate asymptotics. As an application, we verify certain Fredholm property of the linearized operator of zeta-instanton equation.

9.6. Inversion of operator pencils on Banach space using Jordan chains

Geetika Verma (University of South Australia)

14:20 Fri 6 December 2019 – 134

Dr Geetika Verma

In this talk, I will discuss the inversion of operator pencils on Banach spaces. The main aim is to find a basic solution to the fundamental equations and hence construct a Laurent series representation for the resolvent operator on the given annulus. Assuming that the generalized resolvent operator has an isolated essential singularity and that it is analytic on some annular region centred at the singularity and further assume—without loss of generality—that the singularity is located at the origin. On each such annular region, I will show that the complementary projections which separate the two components of the spectral sets are uniquely determined by the generating subspaces for the associated infinite-length Jordan chains. I will use these Jordan chains to find the key projection operators and thereby obtain the desired direct sum decompositions for the domain and range spaces.

10. Geometric Analysis and Partial Differential Equations

10.1. The prescribed Ricci curvature problem for naturally reductive metrics on compact Lie groups: general theory

Romina Melisa Arroyo (University of Queensland)

16:00 Wed 4 December 2019 – 136

Dr Romina Melisa Arroyo, Dr Artem Pulemotov

An interesting open problem is to find a Riemannian metric whose Ricci curvature is prescribed, that is, a Riemannian metric g and a real number $c > 0$ satisfying

$$\mathrm{Ric}(g) = cT,$$

for some fixed symmetric $(0,2)$-tensor field T on a manifold M, where $\mathrm{Ric}(g)$ denotes the Ricci curvature of g.

The aim of this talk is to discuss this problem within the class of naturally reductive metrics when M is a compact simple Lie group, and present recently obtained results in this setting.

This talk is based on work in progress with Artem Pulemotov (The University of Queensland).

10.2. Hyperbolic 3-manifolds, embeddings and an invitation to the Cross Curvature Flow

Paul Bryan (Macquarie University)

13:55 Wed 4 December 2019 – 136

Mr Paul Bryan

Hyperbolic three manifolds, particularly those of finite volume, are important in the study of three-manifold topology. Out of the eight geometries arising in Thurston's geometrisation program, only the hyperbolic ones are not explicitly. The cross curvature flow was introduced by Hamilton and Chow as a promising tool for negatively curved metrics to hyperbolic metrics. There is a natural integrability condition ensuring isometric embeddability in Minkowksi space as a spacelike co-compact hypersurface in which case the cross curvature flow is equivalent to the Gauss curvature flow. By Andrews et. al. the situation is completely understood with smooth convergence to a hyperbolic metric. The general case remains an open problem, yet some results are known in favour of the general case such as stability of the hyperbolic metric due to Knopf and Young as well as monotone quantities.

10.3. Existence of sharp asymptotic profiles of singular solutions to an elliptic equation with a sign-changing nonlinearity

Florica Corina Cirstea (The University of Sydney)

16:25 Tue 3 December 2019 – 136

Florica C. Cîrstea, Frédéric Robert and Jérôme Vétois

In this talk, I will discuss recent joint work with Frédéric Robert (University of Lorraine) and Jérôme Vétois (McGill University) in which we settle the open question of the actual existence of all the singular profiles ascertained earlier by the speaker with F. Robert [Proc London Math Soc, 114 (2017)] for the positive smooth solutions to the nonlinear elliptic equation

$$-\Delta u = \frac{u^{2^*(s)-1}}{|x|^s} - \mu u^q \quad \text{in } B_R(0)\setminus\{0\}.$$

Here, $B_R(0)$ denotes the open ball of radius R centred at 0 in $\mathbb{R}^n$ for $n \geq 3$, $\mu > 0$, $q > 1$, $s \in (0,2)$ and $2^*(s) := 2(n-s)/(n-2)$.

10.4. The fundamental gap in a negatively curved domain

Julie Clutterbuck (Monash University)

14:20 Wed 4 December 2019 – 136

T Bourni, J Clutterbuck, XH Nguyen, A Stancu, G Wei, V Wheeler

I will give an example of a negatively curved domain in which the fundamental gap— the difference between the first two eigenvalues– behaves quite differently to the flat or positively curved cases. Furthermore, the first eigenfunction fails to possess the property of quasi-convexity.

10.5. Symmetric biharmonic maps

Matthew Kevin Cooper (University of New England)

14:20 Fri 6 December 2019 – 136

Matthew Cooper, Andreas Gastel

Biharmonic maps are higher-order analogues to harmonic maps. They are solutions to a fourth-order elliptic PDE, as opposed to a second-order equation in the harmonic map case. Similarly to harmonic maps, biharmonic maps relate to applications in continuum mechanics and materials science, and geometry, to name just two. The approach we take to building an understanding of biharmonic maps is to study them in highly-symmetric situations. This reduces the fourth-order elliptic PDE to a fourth-order ODE. Through this we find interesting connections to higher-order Hamiltonian dynamics. In this talk, I will give a motivating introduction to biharmonic maps, and then talk about the techniques I and co-authors have developed in order to study the resulting fourth-order ODE, and how this relates to interesting biharmonic maps.

10.6. A free boundary problem driven by the biharmonic operator

Serena Dipierro (The University of Western Australia)

13:30 Wed 4 December 2019 – 136

Assoc Prof Serena Dipierro

In this talk we review some recent results obtained in collaboration with A. Karakhanyan and E. Valdinoci concerning a new type of free boundary problem involving the biLaplacian. In particular, we discuss the analytic and geometric properties of the minimisers.

10.7. Singular quasilinear elliptic equations with gradient dependent nonlinearities

Maria Farcaseanu (The University of Sydney)

17:40 Tue 3 December 2019 – 136

Dr Maria Farcaseanu

We obtain Liouville type results for quasilinear elliptic equations with singular potentials and gradient dependent nonlinearities. Furthermore, we also analyse the behaviour near zero for the positive solutions of such equations. This is a joint work with Florica Cîrstea and supported by the ARC DP190102948.

10.8. Existence Results for Nonlinear Fractional Differential Equations

Nicholas Fewster-Young (University of South Australia)

17:15 Tue 3 December 2019 – 136

Mr Nicholas Fewster-Young

The study of fractional differential equations has been a field of research which has sparked huge interest over at least the last 20 years due its applications in modelling real world phenomena, in such areas of Cancer research, Biology, Physics and Engineering. Fractional Calculus was first introduced by Leibniz in 1695 to generalised integer derivatives to non-integer derivatives. This lead to differential equations and the research of understanding qualitative and quantitative behaviour of these dynamical systems. The theory is dense and well covered in the case of linear fractional differential equations, however, the nonlinear scenarios which are more complex, face challenges and in particular the commutative nature of the derivatives. One of the first steps and a main goal is to understand the qualitative nature of nonlinear fractional differential equations such that they are useful for modelling. The main aim of this talk is to present novel existence results and a priori bounds on solutions to nonlinear case where the order is between 1 and 2 by the use of topological methods.

10.9. Global methods for semi-linear hyperbolic equations

Jesse Gell-Redman (AMSI/University of Melbourne)

14:20 Tue 3 December 2019 – 136

Dr Jesse Gell-Redman

I will describe several results related to small data existence for inhomogeneous semi-linear hyperbolic equations which utilise the groundbreaking method, pioneered by Andras Vasy, in which one constructs propagators for linear hyperbolic operators using global propagation of singularities estimates.

10.10. Ill-posedness of the Camassa-Holm and related equations in the critical space

Zihua Guo (Monash University)

13:55 Fri 6 December 2019 – 136

Zihua Guo, Xingxing Liu, Luc Molinet, Zhaoyang Yin

We prove norm inflation and hence ill-posedness for a class of shallow water wave equations, such as the Camassa-Holm equation, Degasperis-Procesi equation and Novikov equation etc., in the critical Sobolev space $H^{3/2}$ and even in the Besov space $B^{1+1/p}_{p,r}$ for $p \in [1,\infty], r \in (1,\infty]$. Our results cover both real-line and torus cases (only real-line case for Novikov).

10.11. Singularities of Axially Symmetric Volume Preserving Mean Curvature Flow

Sevvandi Priyanvada Kandanaarachchi (Monash University)

15:35 Fri 6 December 2019 – 136

Dr Sevvandi Priyanvada Kandanaarachchi

We investigate the formation of singularities for surfaces evolving by volume preserving mean curvature flow. For axially symmetric flows - surfaces of revolution - in $\mathbb{R}^3$ with Neumann boundary conditions, we prove that the first developing singularity is of Type I. The result is obtained without any additional curvature assumptions being imposed, while axial symmetry and boundary conditions are justifiable given the volume constraint. Additional results and ingredients towards the main proof include a non-cylindrical parabolic maximum principle, and a series of estimates on geometric quantities involving gradient, curvature terms and derivatives thereof. These hold in arbitrary dimensions.

10.12. Quantitative comparison theorems in geometry

Kwok-Kun Kwong (University of Wollongong)

15:10 Fri 6 December 2019 – 136

Dr Kwok-Kun Kwong

The classical volume comparison states that under a lower bound on the Ricci curvature, the volume of the geodesic ball is bounded from above by that of the ball with the same radius in the model space. On the other hand, counterexamples show that the assumption on the Ricci curvature cannot be weakened to a lower bound on the scalar curvature, which is the average of the Ricci curvature. In this talk, I will show that a lower bound on a weighted average of the Ricci curvature is sufficient to ensure volume comparison. In the course I will also show a sharp quantitative volume estimate, an integral version of the Laplacian comparison theorem, and some applications. If time allows, I will also present some extensions of the theorem.

10.13. A fully nonlinear flow of three-convex hypersurfaces

Stephen Lynch (University of Tubingen)
15:35 Wed 4 December 2019 – 136
Stephen Lynch

We will discuss a fully nonlinear geometric flow of three-convex hypersurfaces, where the normal speed at each point of the solution is given by a concave function of the second fundamental form. Three-convexity means that at each point, the sum of the smallest three principal curvatures is positive. This flow smoothly deforms any compact three-convex initial hypersurface, preserving three-convexity, until its curvature becomes unbounded. Our main result is a convexity estimate, which says that high-curvature regions are approximately convex. Such an estimate is known to hold for mean-convex mean curvature flow, and for a large class of fully nonlinear flows where the speed function is convex. For concave speeds, previous results of this kind assume two-convexity, and make essential use of this property.

10.14. The Semilinear Calderon Problem on Complex Manifolds

Yilin Ma (The University of Sydney)
16:00 Tue 3 December 2019 – 136
Mr Yilin Ma

The study of the Calderon inverse problems have been extended to the semilinear case on open bounded domains of real spaces. However, results towards the direction of manifolds have been rather limited.

We begin by formulating the classical Calderon problem. Roughly speaking, the Calderon problem is the determination of coefficients in the Schrodinger operator from boundary measurements.

We will show that, solving the semilinear Calderon problem under analytic conditions prescribed on the coefficients of the associated Schrodinger operator reduces the problem to solving the linearized Calderon problem. This is equivalent to finding sufficiently many harmonic functions. In the case where only partial measurements on the boundary are available, these harmonic functions would be required to vanish everywhere on the boundary expect on a small open set. This constitutes the main difficulty of the problem.

10.15. The prescribed Ricci curvature problem for naturally reductive metrics on compact Lie groups: examples

Artem Pulemotov (The University of Queensland)
16:25 Wed 4 December 2019 – 136
Dr Artem Pulemotov

Let G be a compact Lie group. Naturally reductive left-invariant metrics form an important class of Riemannian metrics on G (we denote it $\mathscr{M}_{\mathrm{nat}}$) nested between the class of all left-invariant metrics and the class of bi-invariant ones. In the talk, we discuss the prescribed Ricci curvature equation $\mathrm{Ric}\, g = cT$ assuming $T \in \mathscr{M}_{\mathrm{nat}}$. The unknowns here are the metric g and the scaling factor c. After a quick review of the general theory, we will focus on examples that explain the nature of solutions and reveal several surprising phenomena. Joint work with Romina Arroyo (The University of Queensland).

10.16. Higher-order Cheeger and Buser inequalities, and a dynamics application

Christopher P Rock (UNSW Sydney)
15:35 Tue 3 December 2019 – 136
Mr Christopher P Rock

Higher-order Cheeger constants describe how efficiently a manifold can be separated into k large pieces using small cuts. These have been proven to be equivalent to the kth eigenfunction of the (optionally weighted) Laplacian up to polynomials in k, on geodesically convex manifolds with non-negative Bakry-Emery Ricci curvature. We will present new bounds which apply to manifolds with negative Ricci curvature bounds and which do not depend on k, but will instead depend on the dimension of the manifold and the Lipschitz constant of the weight, or on the number of nodal domains in an eigenfunction. We apply these results to justify an algorithm for finding *coherent sets* in time-varying dynamical systems, i.e. dynamically separated subsets of the phase space. Coherent sets are identified using a dynamic version of the higher-order Cheeger constants. They are detected using eigenfunctions of the weighted Laplacian for a modified metric, called the *dynamic Laplacian*.

10.17. On the stability of expanding black hole spacetimes

Volker Schlue (The University of Melbourne)
15:10 Tue 3 December 2019 – 136
Dr Volker Schlue

In the context of Einstein's equations with positive cosmological constant, the Kerr de Sitter family of solutions are a model of a black hole in the expanding universe. In this talk, I will focus on a stability problem for the expanding region, which can be formulated as a characteristic initial value problem to the future of the cosmological horizons. I will briefly summarise my work on the decay of the conformal Weyl curvature in this setting, and present recent progress on the global construction of optical functions in de Sitter, and describe their relevance for my approach to this problem in double null gauge.

10.18. An epiperimetric inequality approach to the parabolic Signorini problem

Wenhui Shi (Monash University)

14:45 Wed 4 December 2019 – 136

Ms Wenhui Shi

In this talk I will discuss an epiperimetric inequality associated to the parabolic Signornini problem, and show how it can be used to study the asymptotic behavior of the solution around certain free boundary points, as well as the regularity of the free boundary.

10.19. Nonlocal minimal graphs in the plane are generically sticky

Enrico Valdinoci (The University of Western Australia)

13:30 Fri 6 December 2019 – 136

Prof Enrico Valdinoci

We prove that nonlocal minimal graphs in the plane exhibit generically stickiness effects and boundary discontinuities. More precisely, we show that if a nonlocal minimal graph in a slab is continuous up to the boundary, then arbitrarily small perturbations of the far-away data produce boundary discontinuities. Hence, either a nonlocal minimal graph is discontinuous at the boundary, or a small perturbation of the prescribed conditions produces boundary discontinuities. The proof relies on a sliding method combined with a fine boundary regularity analysis, based on a discontinuity/smoothness alternative. Namely, we establish that nonlocal minimal graphs are either discontinuous at the boundary or their derivative is Hölder continuous up to the boundary. In this spirit, we prove that the boundary regularity of nonlocal minimal graphs in the plane "jumps" from discontinuous to differentiable, with no intermediate possibilities allowed. In particular, we deduce that the nonlocal curvature equation is always satisfied up to the boundary. These results have been obtained in collaboration with Serena Dipierro and Ovidiu Savin.

10.20. Horospherically convex geometry in hyperbolic space and geometric flows

Yong Wei (Australian National University)

17:15 Wed 4 December 2019 – 136

Dr Yong Wei

I will introduce some geometric structures of horospherically convex hypersurfaces in hyperbolic space, including horospherical support function, horospherical Gauss map and hyperbolic principal curvature radii, which can be viewed as hyperbolic analogue of the convex geometry in Euclidean space. Then I will discuss some results on geometric flows driven by smooth functions of hyperbolic principal curvature radii.

10.21. Counterexamples to graph preservation under mean curvature flow

Valentina-Mira Wheeler (University of Wollongong)

16:50 Wed 4 December 2019 – 136

Dr Valentina-Mira Wheeler

Mean curvature flow is the steepest descent gradient flow for the area functional, making it a difficult flow to obtain a long time existence result for geometric objects that flow without an additional restriction. One can see this in a “simple” way by using convex objects as barriers. The celebrated result of Huisken showing that convex bodies under mean curvature flow will shrink out of existence in finite time allows us to prove the extinction of any other object contained inside (in the case they do not become non smooth before that). One property of the solution that facilitates the long time existence proof is that of being graphical. A mean curvature flow solution that is graphical is equivalent to a second order quasilinear strictly parabolic partial differential equation for which one can employ parabolic methods to obtain long time existence. Under graphicality Ecker and Huisken proved in ’89 that entire solutions of the mean curvature flow exist for all times. For boundary value problems one has to consider further arguments to manage maintaining initial graphicality up to and including the boundary. In this short talk we show that for hypersurfaces moving by mean curvature flow with free boundary, preservation of graphicality holds only in very special circumstances. That is we prove that for any non-cylindrical smooth support hypersurface there exist smooth mean curvature flows with graphical initial data and free boundary on this hypersurface that become non-graphical in finite time. This is joint work with Ben Andrews (ANU).

10.22. Short time existence for higher order curvature flows with and without boundary conditions

Yuhan Wu (University of Wollongong)

16:50 Tue 3 December 2019 – 136

Ms Yuhan Wu

We prove short time existence for higher order curvature flows of plane curves with and without generalised Neumann boundary condition and describe how these results fit into a broader framework for analysis of the behaviour of these flows.

11. Geometry including Differential Geometry

11.1. On the signature of the Ricci curvature on nilmanifolds

Romina Melisa Arroyo (University of Queensland)

15:35 Tue 3 December 2019 – 186

Dr Romina Melisa Arroyo, Dr Ramiro Augusto Lafuente

One of the most important challenges of Riemannian geometry is to understand the Ricci curvature. A problem that is still open is: determine all possible signatures of the Ricci curvature of all Riemannian metrics on a given manifold. The aim of this talk is to present the problem in the setting of nilpotent Lie groups with left-invariant metrics, and give an answer in the case that the nilpotent Lie group admits a nice basis.

This talk is based on work in progress with Ramiro Lafuente (The University of Queensland).

11.2. Positive curvature in dimension seven

Owen Dearricott (The University of Melbourne)

15:35 Fri 6 December 2019 – 186

Dr Owen Dearricott

I will detail a general construction for putting positive sectional curvature on a series of 7-manifolds discussed as viable candidates to carry positively curved metrics with co-dimension one principal orbits discussed by Grove, Wilking and Ziller in JDG in 2008 by appropriately modifying a naturally occurring 3-Sasakian metric. This builds on previous work where I considered isolated examples of this sort where the base Bianchi IX self-dual Einstein orbifold metric had an algebraic closed form.

11.3. Distinguished curves and integrability in Riemannian and conformal geometry

A. Rod Gover (The University of Auckland)

13:55 Thu 5 December 2019 – 183

Prof A. Rod Gover

A new characterisation is described for the unparametrised geodesics, or distinguished curves of pseudo-Riemannian and conformal geometry. The characterisation is a type of moving incidence relation and most importantly it leads naturally to a very general theory and construction of quantities that are necessarily conserved along the curves. (As used in geometry and geometric analysis as way of simplifying the problem of determining such curves.) In this the usual role of Killing tensors and conformal Killing tensors is recovered, but the construction shows that a vastly larger class of equation solutions can also yield curve first integrals. Next it turns out that the ideas lead to yet one more way to understand pseudo-Riemannian geodesics and this has applications into understanding and treating the distinguished curves of structures with singular metrics such as Poincare-Einstein manifolds and their generalisations.

This talk is based on joint work with Daniel Snell and Arman Taghavi-Chabert

11.4. Group Extensions and Bundle Gerbes

Parsa Kavkani (The University of Adelaide)

16:00 Tue 3 December 2019 – 186

Mr Parsa Kavkani

Line bundles on a manifold M provide a geometric realisation of the second integral cohomology of M via their chern class. Similarly bundle gerbes provide a geometric realisation of the third integral cohomology of M via their Dixmier-Douady class. An important example of bundle gerbes is the lifting bundle gerbe. In this talk I will review some constructions of groups extensions, introduce the notion of bundle gerbe and explain how the lifting bundle gerbe is associated to group extensions.

11.5. Rolling Symmetric Spaces

Krzysztof Krakowski (Cardinal Stefan Wyszynski University in Warsaw)

14:20 Fri 6 December 2019 – 186

Dr Krzysztof Krakowski

Mechanical model of a surface rolling upon another one, without a slip or twist, both embedded in R^3, serves as the most classical non-holonomic differential system with a $(2,3,5)$ distribution D. It is well known that given a curve on one of these surfaces, there always exists the unique rolling map, that traces the point of contact along that curve.

I shall discuss the simple case of a symmetric space rolling upon a hyperplane, both embedded in Euclidean or pseudo-Euclidean space. These systems draw many similarities with the classical example of a sphere rolling upon a plane, and may be described in terms of Lie algebra. However, somewhat surprising is the way these symmetric spaces should be embedded. I shall illustrate recent results with some simple and some, perhaps, not so simple examples.

11.6. Conservation laws and parabolic Monge-Ampere equations

Benjamin Blake McMillan (The University of Adelaide)

13:30 Thu 5 December 2019 – 183

Dr Benjamin Blake McMillan

In this talk, I will describe how the geometry of an arbitrary parabolic second order equation governs the existence of its conservation laws, and conversely, how the existence of even a single conservation law puts strong geometric restrictions on a parabolic equation. In particular, I will describe the strong connection between conservation laws and parabolic Monge-Ampere equations.

11.7. On cylindricity of submanifolds of nonnegative Ricci curvature in a Minkowski space

Yuri Nikolayevsky (La Trobe University)

13:30 Fri 6 December 2019 – 186

Dr Yuri Nikolayevsky

By the Splitting Theorem of Cheeger-Gromoll, a complete Riemannian manifold M^n of non-negative Ricci curvature which contains a *line* (a complete geodesic every arc of which minimises the distance between its endpoints) is the Riemannian product $N^{n-1} \times \mathbb{R}$. The counterpart of this result in submanifold geometry is as follows: a complete Riemannian submanifold $M^n \subset \mathbb{R}^{n+p}$ of non-negative Ricci curvature which contains a line (of $\mathbb{R}^{n+p}$) is the cylinder $N^{n-1} \times \mathbb{R} \subset \mathbb{R}^{n+p-1} \times \mathbb{R}$.

A direct translation of these results to the Finsler settings by replacing the Euclidean ambient space by a Minkowski space and the Ricci curvature, by the Ricci curvature of the induced Finsler metric on the submanifold, most likely, does not work. The reason for that is the fact that in Finsler geometry, the connection between the Ricci (or the flag) curvature of a submanifold and its shape is much weaker than that in Riemannian geometry. For example, we constructed an example of a (locally) strictly saddle surface of positive flag curvature in a three-dimensional Minkowski space.

We consider submanifolds of non-negative Ricci curvature in a Minkowski space which contain a line or whose relative nullity index is positive. For hypersurfaces, submanifolds of codimension two or of dimension two, we prove that such a submanifold is a cylinder, under certain conditions on the inertia of the pencil of the second fundamental forms.

This is a joint work with A.Borisenko.

11.8. Superintegrable systems

Jeremy Nugent (University of New South Wales)

17:15 Tue 3 December 2019 – 186

Mr Jeremy Nugent

TBA

11.9. Locally conformal Käler or symplectic structures on compact solvmanifolds

Marcos Origlia (Monash University)

15:10 Fri 6 December 2019 – 186

Dr Marcos Origlia

We study locally conformal Kähler (LCK) manifolds, that is, a Hermitian manifold (M, J, g) such that on each point there exists a neighborhood where the metric is conformal to a Kähler metric. Equivalently, (M, J, g) is LCK if and only if there exists a closed 1-form θ such that $d\omega = \theta \wedge \omega$, where ω is the fundamental 2-form determined by the Hermitian structure. The 1-form θ is called the Lee form. On the other hand, the concept of LCK structure can be generalized to the notion of locally conformal symplectic (LCS) structure, that is a pair (ω, θ) satisfying $d\omega = \theta \wedge \omega$, where ω is a non-degenerate 2-form and θ is a closed 1-form.

In this talk, we discuss left-invariant LCK or LCS structures on solvable Lie groups and the existence of lattices (co-compact discrete subgroups) on these Lie groups in order to obtain compact solvmanifolds equipped with these kinds of locally conformal geometric structures.

11.10. The prescribed Ricci curvature equation on $(SU(2) \times SU(2))/U(1)_r$

Artem Pulemotov (The University of Queensland)

15:10 Tue 3 December 2019 – 186

Dr Artem Pulemotov

Let T be a positive-definite G-invariant (0,2)-tensor field on a homogeneous space G/H. We discuss the prescribed Ricci curvature equation $\mathrm{Ric}\, g = cT$, where the unknowns are the Riemannian metric g on G/H and the positive number c. Solutions to this equation are critical points of the scalar curvature functional subject to a trace constraint. We present their complete classification assuming $G = SU(2) \times SU(2)$ and $H = U(1)$ with an “asymmetric" embedding. Our results provide insights into the behaviour of the scalar curvature functional in the general setting. Joint work with Wolfgang Ziller (The University of Pennsylvania).

11.11. Kähler manifolds, Sasakian manifolds and generalised Taub-NUT solutions

Gerd Schmalz (University of New England)

16:50 Tue 3 December 2019 – 186

Gerd Schmalz, Masoud Ganji

The Taub-NUT solution is a Ricci-flat Lorentzian spacetime. It admits a shear free congruence, i.e. a foliation into null-geodesics the flow along which preserves the conformal class of the Lorentzian metrics restricted to perpendicular subspaces. The leaf space of the foliation has a natural CR structure, which in the case of the classical Taub-NUT and Kerr solutions is Sasakian. Since Sasakian structures are intimately related to Kähler geometry, it is natural to investigate the relationship between Kähler geometry and Ricci-flat Lorentzian geometry. I will present a construction of higher dimensional generalisations of the Taub-NUT space related to certain Kähler-Einstein manifolds. This is joint work with Masoud Ganji.

11.12. Second order superintegrable systems in arbitrary dimension

Andreas Vollmer (University of New South Wales)

13:55 Fri 6 December 2019 – 186

Dr Andreas Vollmer

Broadly speaking, second order superintegrable systems are to date classified for conformally flat geometries in dimension 2 and 3 only. However, the methods do not carry over to higher dimension, as the underlying system of partial differential equations quickly grows and becomes tedious to handle. A new, algebraic-geometric approach has recently been suggested by Kress & Schoebel (2019), and was successfully applied to (non-degenerate) second order superintegrable systems on 2-dimensional Euclidean geometry. Extending this approach to suit any dimension, and non-Euclidean geometries, we can characterize second-order superintegrable systems (under very mild extra assumptions) by smooth (0,3)-tensor fields (structure tensors).

These superintegrable structure tensors are governed by a simple set of algebraic equations. For spaces of constant sectional curvature, the situation simplifies further, giving rise to two scalar functions that characterize the structure tensor. This framework lays the groundwork for an algebraic-geometric classification of second-order superintegrable systems in any dimension (joint work with Jonathan Kress and Konrad Schoebel). Time permitting, the talk will also address conformally superintegrable systems.

12. Harmonic and Semiclassical Analysis

12.1. Vector-valued time-frequency analysis and the bilinear Hilbert transform

Alex Amenta (University of Bonn)

14:20 Wed 4 December 2019 – 134
Dr Alex Amenta

The bilinear Hilbert transform is a bilinear singular integral operator which is invariant not only under translations and dilations, but also under modulations. This additional symmetry turns out to make proving L^p-bounds especially difficult. I will give an overview of how time-frequency analysis is used in proving these L^p-bounds, with focus on the recently understood setting of functions valued in UMD Banach spaces.

12.2. Construction of Multidimensional Prolate Spheroidal Wave Functions

Hamed Baghal Ghaffari (The University of Newcastle)

15:35 Wed 4 December 2019 – 134
Mr Hamed Baghal Ghaffari

We investigate the construction of multidimensional prolate spheroidal wave functions using techniques from Clifford analysis. The prolates are eigenfunctions of a time-frequency limiting operator, but we show that they are also eigenfunctions of a differential operator. In an effort to compute solutions of this operator, we prove a Bonnet formula for a class of Clifford- Gegenbauer polynomials.

12.3. Sharp endpoint estimates for Schrödinger groups

Xuan Duong (Macquarie University)

13:30 Wed 4 December 2019 – 134
Prof Xuan Duong

Let L be a non-negative self-adjoint operator satisfying the generalized Gaussian (p_0, p_0') estimates of order m for some $1 \le p_0 < 2$. We proved sharp endpoint L^p-Sobolev bound for the Schrödinger group e^{itL} that for every $p \in (p_0, p_0')$,

$$\left\|(I+L)^{-s}e^{itL}f\right\|_p \le C(1+|t|)^s\|f\|_p, \quad s \ge n\left|\frac{1}{2}-\frac{1}{p}\right|.$$

As a consequence, the above estimate holds for all $1 < p < \infty$ when L satisfies a Gaussian upper bound. This extends classical results due to Feffermann-Stein and Miyachi for the Laplacian on the Euclidean spaces $\mathbb{R}^n$. This is joint work with Peng Chen, Ji Li, Liang Song and Lixin Yan (2018, 2019).

12.4. Weighted Lebesgue and BMO norm inequalities for the Calderon and Hilbert operators

Guillermo Javier Flores (Universidad Nacional de Cordoba)

16:25 Wed 4 December 2019 – 134
Dr Guillermo Javier Flores

Necessary and sufficient conditions are given for generalized Calderon and Hilbert operators to be bounded from weighted Lebesgue spaces into suitable weighted BMO and Lipschitz spaces. Moreover, we have obtained new results on the boundedness of these operators from the space of essentially bounded measurable functions into BMO, even in the unweighted case for the Hilbert operator. The class of weights involved are close to the doubling and reverse Holder conditions related to the Muckenhoupt classes.

12.5. A Fredholm approach to solving semilinear evolution equations

Andrew Hassell (Australian National University)

13:55 Wed 4 December 2019 – 134
Prof Andrew Hassell

I will talk about a new approach to solving semilinear elliptic, and evolution equations of Schrodinger and wave type, using a global Fredholm approach developed recently by Vasy. This is joint work with Jesse Gell-Redman, Jacob Shapiro and Junyong Zhang.

12.6. Commutators of Cauchy-Szego type integrals for domains in C^n with minimal smoothness

Ji Li (Macquarie University)

14:20 Thu 5 December 2019 – 134
Dr Ji Li

We established the characterisations of boundedness and compactness for commutators of Cauchy-Szego type integrals for domains in C^n with minimal smoothness with respect to the BMO and VMO spaces, respectively.

We note that

(1) such Cauchy-Szego type integral is not a standard Calderon–Zygmund operator. Our result is the first one to provide full characterisations of commutators for singular integrals with non-smooth kernels.

(2) the approach for compactness is new, and it recovers all previously known results obtained from the method of Uchiyama.

12.7. An improved heat kernel bound for certain magnetic Schrodinger operators.

Fu Ken Ly (The University of Sydney)

16:50 Wed 4 December 2019 – 134

Dr Fu Ken Ly

We derive an improved heat kernel bound for certain magnetic Schrodinger operators. The proof utilises an improved Fefferman-Phong inequality due to B. Ben Ali.

This is joint work with The Anh Bui.

12.8. Non-homogeneous $T(1)$ theorem for singular integrals on product quasimetric spaces

Trang Thi Thien Nguyen (University of South Australia)

16:00 Wed 4 December 2019 – 134

Ms Trang Thi Thien Nguyen

In the Calderón–Zygmund theory of singular integrals, the $T(1)$ theorem of David and Journé is one of the most celebrated theorems. It gives an easily-checked criterion for a singular integral operator T to be bounded from $L^2(\mathbb{R}^n)$ to $L^2(\mathbb{R}^n)$. The setting of this classical result is Euclidean space $\mathbb{R}^n$, equipped with the usual Euclidean metric and Lebesgue measure. In particular, the functions f that the operator T acts on are defined on $\mathbb{R}^n$. Since then, the $T(1)$ theorem has been generalised to various settings.

In this talk, I will discuss our work in progress on generalising the $T(1)$ theorem, that brings together three attributes: 'product space', 'quasimetric' and 'non-doubling measure'. Specifically, we prove a $T(1)$ theorem that can be applied to operators acting on functions defined on product spaces $(X_1 \times X_2, \rho_1 \times \rho_2, \mu_1 \times \mu_2)$ equipped with a quasimetric $\rho_1 \times \rho_2$ and an upper doubling measure $\mu_1 \times \mu_2$, which only satisfies an upper control on the size of balls, but need not be doubling.

12.9. Scattering from infinity for semi-linear wave equations with weak null condition

Volker Schlue (The University of Melbourne)

14:45 Wed 4 December 2019 – 134

Dr Volker Schlue

In this talk I present global existence results backwards from scattering data for various semilinear wave equations on Minkowski space satisfying the (weak) null condition. These models are motivated by the Einstein equations in harmonic gauge, and the data is given in the form of the radiation field. It is shown in particular that the solution has the same spatial decay as the radiation field along null infinity. I will discuss the proof which relies, on one hand on a fractional Morawetz estimate, and on the other hand on the construction of suitable approximate solutions from the scattering data.

12.10. Spectral multipliers without semigroup framework and application to random walks

Adam Sikora (Macquarie University)

13:55 Thu 5 December 2019 – 134

Dr Adam Sikora

We discuss spectral multiplier theorems for abstract self-adjoint operators on spaces of homogeneous type. We work outside the semigroup context. We introduce a restriction type estimates à la Stein-Tomas. This allows us to obtain sharp spectral multiplier theorems and hence sharp Bochner-Riesz summability results in some situation. As an application we prove sharp Bochner-Riesz summability results for the random walk on the integer lattice $\mathbb{Z}^n$.

The talk is based on joint work with Peng Chen, El Maati Ouhabaz and Lixin Yan.

12.11. Product Hardy space theory on spaces of homogeneous type via orthonormal wavelet bases

Lesley Ward (University of South Australia)

13:30 Thu 5 December 2019 – 134

Assoc Prof Lesley Ward

I will discuss recent joint work with Yongsheng Han, Ji Li and Cristina Pereyra. We establish the theory of product Hardy spaces defined on product spaces of homogeneous type $\widetilde{X} = X_1 \times X_2$. Here each factor (X_i, d_i, μ_i), $i = 1, 2$, is a space of homogeneous type in the sense of Coifman and Weiss, in other words, a set X_i equipped with a quasi-metric d_i and a Borel-regular doubling measure μ_i. We make extensive use of the orthonormal wavelet expansion of Auscher and Hytönen. No additional assumptions are made on the quasi-metrics d_i, nor on the measures μ_i.

We show that the wavelet expansion converges for suitable test functions and distributions. We develop the product Littlewood–Paley theory for appropriate discrete and continuous square functions defined in terms of the wavelets. We define the Hardy spaces $H^p(\widetilde{X})$ and the Carleson measure spaces $\mathrm{CMO}^p(\widetilde{X})$, including the special case $\mathrm{BMO}(\widetilde{X}) = \mathrm{CMO}^1(\widetilde{X})$, as well as $\mathrm{VMO}(\widetilde{X})$. We prove the duality relations $H^1(\widetilde{X})^* = \mathrm{BMO}(\widetilde{X})$ and $\mathrm{VMO}(\widetilde{X})^* = H^1(\widetilde{X})$. We establish the Calderón–Zygmund decomposition for $H^p(\widetilde{X})$, deduce interpolation theorems, and develop an atomic decomposition for $H^p(\widetilde{X})$. I will mention some applications of our results.

13. Inclusivity, diversity, and equity in mathematics

13.1. Maths on country

Rowena Ball (The Australian National University)
16:00 Tue 3 December 2019 – G61
Assoc Prof Rowena Ball

Deep in the heart of the NW Qld Gulf savannah country, in a shed by a water tank at the back of the railway yard, there was a school. During the later years of government-enforced racial segregation, from around the 1930s to the 1960s, the school educated Aboriginal children. Despite official indifference, habitually drunken white teachers, and the mile-and-a-half distance from the reserve, the school persisted because Aboriginal parents and community valued – and have always valued – formal education for their children. That this is especially the case with maths and science has in recent years been recognised, with establishment of the hugely popular regional STEM camps for Indigenous middle-school students, and STEM summer schools for Year 11 run by universities. In this talk I shall describe some of the associated maths outreach and enrichment activities I am involved in. I shall also touch on some new research to elucidate a mathematical transform practised by the Euahlayi people, and probably other groups.

13.2. Equity considerations and design of mathematics outreach to schools

Yudhistira Andersen Bunjamin (UNSW Sydney)
16:25 Tue 3 December 2019 – G61
Yudhistira Andersen Bunjamin, Diana Combe, Michael Denes, Aditya Ganguly, Manzoor Khan, Aldhytha Karina Sari and many, many others

Recently, we have been designing mathematics workshops for primary and secondary school students, motivated by promoting mathematical thinking rather than by introducing an amusing area or application of mathematics. This project has a short but eclectic history - beginning with a regional outreach trip and involving an entire AMSI summer school, several people from Universities in New South Wales, Victoria and South Australia, the willing engagement of some staff and students at UNSW and the helpful interest and advice of many other experts. Some of our developing workshops have been presented and well-received on various occasions, including this year's AMSI CHOOSEMATHS Day at UTS in Sydney and on several UNSW Science Faculty regional outreach trips to the NSW Central West.

In this talk, we will present some aspects of this design and development process and highlight the considerations which were made as a result of the equity motivation, including mathematical level, cultural sensitivity and accessibility. In particular, we will discuss the interaction between the underlying mathematics and the operational and equity considerations of the workshop.

Joint work with Diana Combe, Michael Denes, Aditya Ganguly, Manzoor Khan, Aldhytha Karina Sari and many, many others.

13.3. Diversity at the Olympiads: Culture change in elite competition

Benjamin Burton (University of Queensland)
15:35 Tue 3 December 2019 – G61
Prof Benjamin Burton

The International Olympiad in Informatics is the premier international competition for secondary students in algorithm design. In many ways it is a model global citizen, governed and developed collaboratively by an international community of around 90 countries. However, it suffers from some well-known diversity problems. These include an alarming gender imbalance, plus the fact that some host countries cannot welcome all members of the community equally, including LGBTIQ participants, or those with diplomatic conflicts.

This talk will examine the history of some of these problems, as well past and present work towards solutions. These include both formal and grassroots initiatives: some developed by the committees that oversee the olympiad, and some driven directly by the member countries. Importantly, we are beginning to understand that it is not enough to fix the symptoms, but in many ways we need to change the culture of the competition and the community of students and trainers who inhabit it. To do this in a way that crosses linguistic, cultural and religious barriers is a difficult and ongoing challenge.

The speaker has been a part of the Olympiad for the last 21 years, including 10 years leading the Australian delegation, and 10 years serving on the scientific and administrative committees that oversee the event.

13.4. CHOOSEMATHS: approaches to increasing female participation in advanced school mathematics

Julia Collins (Edith Cowan University)
16:50 Tue 3 December 2019 – G61
Dr Julia Collins

The CHOOSEMATHS project (2015-2019) has been a 5-year partnership between the Australian Mathematical Sciences Institute (AMSI) and the BHP Foundation. It aimed to turn around community attitudes to, and participation in, mathematics, especially for girls and young women. In this talk I will discuss two aspects of the project that I worked on: CHOOSEMATHS Days and CHOOSEMATHS Mentoring. Both were targeted at female students in Years 9 and 10, and aimed to increase the numbers of students choosing higher levels of mathematics in Year 11/12 (i.e. Methods and Specialist mathematics). CHOOSEMATHS Days were 1-day events held at schools and universities around Australia, while CHOOSEMATHS Mentoring brought together students and mathematical mentors in small groups who communicated regularly online. I will discuss the approaches of both programs and will report on their effectiveness in changing mathematical attitudes among the participants.

13.5. A call to action

Nalini Joshi (The University of Sydney)

15:10 Tue 3 December 2019 – G61
Prof Nalini Joshi

The Australian Mathematical Society established a committee on Equity, Diversity and Inclusion in 2018. I am the Chair. In this talk, I will explain what we have done so far on this committee and what is to come. In particular, we have established a new named lectureship for the annual AustMS conferences, a new special session (in which this talk is being delivered) and a code of conduct. These have procedures attached to them and in this talk I ask you to support our call to action.

13.6. Creating a critical mass of females in engineering mathematics classrooms

Heather Lonsdale (Curtin University)

15:35 Wed 4 December 2019 – G61
Dr Heather Lonsdale, Assoc Prof Natalie Lloyd, Ms Jolanta Szymakowski

The Engineering Foundation Year at Curtin University has been organised for many years into small cohorts of about 20 students who are all allocated to the same tutorials and workshop classes for all units in their first year. This was initially organised to give students a cohort experience with an emphasis on creating diverse groups that were broadly representative of the larger student enrolment in the course, which meant that the female students were divided roughly equally throughout all groups with only a small number in each group.

In 2016, the group organisation was changed to instead prioritise grouping females into a critical mass, aiming to have at least 7 females in a group of 20, for groups where females are present. The rationale for this change was based on research indicating that gender stereotyping and discrimination is minimised in organisations that had achieved 30-35

In this talk we will discuss these cohort arrangements, and some of the research and observations on these cohorts that have fed into the broader literature on the critical mass of females in the classroom.

13.7. Improving accessibility in mathematics

Matthew Mack (Multiple Universities)

14:20 Wed 4 December 2019 – G61
Matthew Mack

Enabling inclusivity and diversity within any population also requires attention be paid to ensuring that activities and events are accessible. Participants with disabilities and/or certain sensitivities and preferences may find it difficult to engage within these events due to circumstances beyond their control.

In this talk, I will address strategies for both mathematics events and teaching that contribute to a more accessible environment, drawing from my own experiences of being hard-of-hearing and from observing similar practices. We will also look at the benefits these strategies bring to other people, as well as the practicalities of implementing them.

13.8. Childcare at a large mathematical conference

Daniel Mathews (Monash University)

13:55 Wed 4 December 2019 – G61
Dr Daniel Mathews

I'll discuss some of the issues around organising childcare for a large mathematical conference such as the AustMS meeting, based on some personal experience.

13.9. Descartes was wrong - The psychology of safety and its implications to equality, diversity, and inclusion

John Ormerod (The University of Sydney)

17:15 Wed 4 December 2019 – G61
Dr John Ormerod

The phrase "Cogito, ergo sum" by Descartes, usually translated to "I think therefore I am", and is one of the most famous quotes from Western Philosophy. This contrasts with Ubuntu philosophy which states: "I am because we are, and since we are, therefore I am." The later statement is more consistent with the science of interpersonal neurobiology which argues that who we are is a composite of the relationships that we have with one another. In implication, each other's psychological safety is dependent upon one other. In turn has huge implications to belonging, creativity, and well being. In addition to this we discuss the advantages to having a psychological safe workplace, and the flow on effects to innovation, motivation, engagement, and improving diversity.

13.10. Responsive Techniques for Teaching Australian, Indigenous School Students: What Part Does Culture Play in Teaching Mathematics?

Collin Grant Phillips (The University of Sydney)

16:00 Wed 4 December 2019 – G61
Dr Collin Grant Phillips

The Mathematics Learning Centre (MLC) has taught the Mathematics component of the STEM workshops (or *Workshops* for short) for Indigenous school students since 2017. The STEM workshops are conducted by the Faculty of Engineering and Information Technologies at the University of Sydney. This talk will discuss some of the methods employed in developing and teaching the *Workshops*. In particular, the methods used to evolve the teaching material, content and learning methods of the *Workshops* from the continual and immediate input from the students will be discussed. This will be demonstrated by outlining how the *Codes and Code Cracking* sessions of the *Workshops* have continually evolved to respond to the students' input, interests and enthusiasm.

The effect of key pillar concepts of worldview, perspective, resilience and cultural competence on the teaching of the *Workshops* and the MLC will be outlined. The use of these principles for teaching mathematics from a cultural perspective will also be discussed.

13.11. WIMSIG resources and initiatives to support careers

Jessica Purcell (Monash University)

13:30 Wed 4 December 2019 – G61
Prof Jessica Purcell

I will discuss upcoming, new, and continuing initiatives by WIMSIG to support women in their careers. These include WIMSIG travel schemes, women in maths gatherings, a pilot mentoring program, and the WIMSIG conference, next scheduled for 1-2 October 2020 at Monash University.

13.12. Hiring for diversity

Jacqui Ramagge (The University of Sydney)

14:45 Wed 4 December 2019 – G61
Prof Jacqui Ramagge

I will look at strategies used to increase diversity. In short, we are all part of the solution.

13.13. Nurture, gender differences and spatial abilities

Asha Rao (Royal Melbourne Institute of Technology)

16:25 Wed 4 December 2019 – G61
Prof Asha Rao

As the number of females doing higher mathematics continues to decrease, it is worth considering how much of a role nurture plays. I will detail a comparison done by researchers from California at San Diego and University of Chicago, on the role that nurture plays in promoting gender differences in spatial abilities.

13.14. Improving the process of organizing conferences and special semesters

Marcy Robertson (The University of Melbourne)

16:50 Wed 4 December 2019 – G61
Dr Marcy Robertson

I will describe in detail a new process in hiring and organizing a recent special semester at the Mathematical Sciences Research Institute (MSRI) aimed at increasing diversity of gender, geographic location and mathematics. I will present the parts that worked, didn't work, and the impressions of myself and other organizers.

13.15. Women in mathematics: one perspective on things that work so far and things that could be done in the future

Valentina-Mira Wheeler (University of Wollongong)

17:15 Tue 3 December 2019 – G61
Dr Valentina-Mira Wheeler

Gender imbalance in academia and in science has been in the attention of the larger community for a while now. Mathematics seems to have been especially impacted by this imbalance in the last century. I will give a short, maybe one sided presentation of things that I have seen have a positive impact on modifying that, based on my perspective as a new woman in mathematics at UOW and in Australia. I will also possibly try to outline some avenues that could be developed in the future.

14. Mathematical Biology

14.1. An Algebraic Inversion-Deletion Model for Bacterial Genome Rearrangement

Chad Mathew Clark (Western Sydney University)

16:25 Wed 4 December 2019 – 187

Mr Chad Mathew Clark

Reversals are a major contributor to variation among bacterial genomes, with studies suggesting that reversals involving small numbers of regions are more likely than larger reversals. While reversals of neighbouring regions, otherwise known as inversions, have been accounted for in both the signed and unsigned case there has yet to be a model which also accounts for the process of deletion without insertion. In this talk, an algebraic model of the inversion-deletion process using the symmetric inverse monoid will be discussed along with exact algorithms for reconstructing the most recent common ancestor of two genomes arising by inversions and deletions. This is joint work with Andrew Francis (Western Sydney University), James Mitchell (University of Saint Andrews) and Julius Jonušas (TU Wien).

14.2. Study of HIV in-host model through multi-pathways infection under different blockers : local and global analysis

Sukhen Das (Jadavpur University)

13:30 Thu 5 December 2019 – 187

Prof Sukhen Das and Nandadulal Bairagi

CD4+ T cells is an important component of our immune system. Human immunodeficiency virus (HIV) infects CD4+ T cells and gradual depletion of CD4+ T cells in the blood plasma is the signature of HIV infection. Traditional models in HIV in-host infection considers spread of infection from free plasma virus to an uninfected CD4+ T cell, known as cell-free mode of infection. Recent studies, however, confirm that infection can also spread from an infected cell to an uninfected cell through virological synapses, known as cell-to-cell mode of infection. Spread of infection and virus replication can be prevented to some extent using retroviral drugs. In this paper we consider a HIV multi-pathway infection model with three blockers and study the system dynamics when these blockers are administered either individually or in combination. Considering all three controls as constant, we prove the local as well as global stabilities of the disease-free and infected steady states.

14.3. The space of tree-based phylogenetic networks

Andrew Francis (Western Sydney University)

13:30 Fri 6 December 2019 – 187

Andrew Francis

Tree-based networks are a class of phylogenetic networks that attempt to formally capture what is meant by "tree-like" evolution. A given non-tree-based phylogenetic network, however, might appear to be very close to being tree-based, or very far. This talk will formalise a range of ways to define tree-based proximity for unrooted phylogenetic networks, one of which (based on the "nearest neighbour interchange (NNI)") gives rise to a notion of "tree-based rank". This provides a subclassification within the tree-based networks themselves, identifying those networks that are "very" tree-based. We also show that the class of tree-based networks as a whole is connected under the NNI, making it potentially searchable using NNI for sampling. This is joint work with Mareike Fischer, Greifswald Universitat, Germany.

14.4. Extrinsic noise and heavy-tailed distributions in gene expression

Lucy Ham (The University of Melbourne)

13:55 Fri 6 December 2019 – 187

Dr Lucy Ham

Gene expression is an inherently stochastic process resulting in significant heterogeneity between cells; a phenomenon that has been widely observed in experimental data. The Telegraph model, as introduced by Ko et al. in 1991, is the canonical model for gene expression, and is commonly invoked as an explanation for this observed heterogeneity. In this talk, we present a number of extensions of the Telegraph model, including one that allows us to incorporate the effects of extrinsic noise, encompassing factors external to the transcription of the individual gene. Crucially, we are able to show that the large variability and over-dispersion in the tails seen in many experimental datasets cannot be captured by the Telegraph model, and must instead reflect extrinsic sources of variability.

14.5. Graded rings of Markov invariants

timothy hewson (University of Tasmania)

14:20 Wed 4 December 2019 – 187

Mr timothy john hewson

By considering binary Markov models on phylogenetic trees and their associated probability distributions, a group action on a tensor product space is naturally identified together with the associated graded ring of invariant functions. In

the case of three taxa and below, these invariants can be completely accounted for; however at four taxa and above the situation becomes much more complicated. This talk will review the methodology we have applied to categorise these functions on higher number of taxa and give results obtained thus far.

14.6. Role of induced plant volatile and refuge in tritrophic model

Dipak Kumar Kesh (Jadavpur University)

14:20 Thu 5 December 2019 – 187

Ritwika Mondal and Dipak Kumar Kesh

Being sessile organism, plant produced volatile plays a major role in plant defense. Plant-induced volatile plays a significant role in plant–herbivore–carnivore interaction. Attraction rate of volatiles influences the immigration rate of carnivores, and hence, predation pressure on herbivores increases. Herbivores take refuge mechanism to protect themselves from carnivore attacks. Based on such biological phenomena, we have formulated a tritrophic model of plant–herbivore–carnivore along with herbivore refuge. The model includes Holling type II functional responses for herbivores and carnivores. Positivity and boundedness of solution of the system, existence of interior equilibrium and its local stability have been shown. The conditions for the global stability of positive equilibrium point is derived. Coexistence of all populations for long time has been studied. Attraction factor of plants volatile to carnivore and herbivore refuge, have been considered as sensitive parameters. Hopf bifurcation has occurred with respect to both of them. The stability of limit cycles during Hopf bifurcation has been studied by computing Lyapunov coefficient. Numerical simulations have been performed to justify our obtained results.

14.7. Emergent signal processing in T cells via regulatory immune mechanisms

Adarsh Kumbhari (The University of Sydney)

17:15 Wed 4 December 2019 – 187

Adarsh Kumbhari; Peter S. Kim; Peter P. Lee, MD

T-cell expansion is governed by regulatory immune mechanisms. Through simple regulatory modules, T cells perform complex operations involving collective decision making and signal processing. Using mathematical modelling, we find that emergent signal processing by T cells results in a change-detection system, both in response to checkpoint and antigen expression. By decomposing the immune response into regulatory modules, we provide a framework that may provide insights into mechanisms of immune resistance to checkpoint inhibitors, and how to optimally modulate immune checkpoints for combination therapies.

14.8. Pattern formation in a reaction-diffusion predator-prey-parasite model with prey infection under the influence of ecological and epidemiological parameters

Nandadulal Nandadulal Bairagi (Jadavpur University)

13:55 Thu 5 December 2019 – 187

Prof Nandadulal Nandadulal Bairagi

This paper deals with the spatial pattern formation in a diffusive predator-prey-parasite model, where predator feeds on infected prey following type II response function and infection spreads among preys through horizontal transmission. We show analytically that diffusion destabilizes the homogeneous steady-state which is otherwise stable. Criteria for various types of instabilities, like Turing, Hopf-Turing and pure Hopf, are presented with illustrations. Our simulation results reveal that this diffusion-driven instability creates various spatiotemporal patterns, like spot, stripe, mixture of spots and stripes, spiral type patterns and clusters depending upon the values of some ecological parameter and diffusion rates. Another interesting observation is that the epidemiological parameters that measure the infection rate and virulence of the disease show opposite patterns with their increasing values.

14.9. Modelling the Immune Response of CD4+ T cells: An intimate relationship between T cells and APCs

Pantea Pooladvand (The University of Sydney)

17:40 Wed 4 December 2019 – 187

Ms Pantea Pooladvand, A/Prof Peter Kim

The clonal expansion of T cells during an infection is a tightly regulated event to ensure an appropriate immune response is mounted against invading pathogens. Although experiments have mapped the dynamics of the response from expansion to contraction, the mechanisms which control this response are not well defined. Here, we propose a model in which the dynamics of T cell expansion is ultimately controlled through continuous interactions between T cells and antigen presenting cells. T cell clonal expansion is proportional to antigen availability and antigen availability is regulated through downregulation of antigen by T cells. We show that our model can predict overall T cell expansion, recruitment into division and burst size per cell. Importantly, the findings demonstrates how an intimate relationship between T cells and APCs can explain the ability of the immune system to tailor its response to dose of antigen, regardless of initial T cell precursor frequencies.

14.10. The ancient Operational Code is embedded in the amino acid substitution matrix and aaRS phylogenies

Julia Shore (University of Tasmania)

14:45 Wed 4 December 2019 – 187

Mrs Julia Shore

Amino-acetyl tRNA synthase (aaRS) are a set of 20 enzymes essential in the biological process of gene expression. For most life forms, they can be divided by their chemical properties into two categories: Class I and Class II. Our analysis aimed to find ways of testing the hypothesis that aaRS enzymes came into existence at the same time as the genetic code and had a role in how it was determined.

The methods for this analysis brought about ways of building a family of stochastic rate matrices from a phylogenetic tree which was then fit to empirical data. It was found that for a given tree, the set of Markov matrices that could be generated formed a closed set under matrix multiplication and addition.

The results of the analysis found that trees which took into account aaRS class fit data better than randomly generated trees. Other chemical properties of interest, particularly polarity of amino acids, were used to build trees and it was found that some types of tree generally fit the data better than ones that only took aaRS class into account. However, it was found in these cases that also including aaRS class into the analysis improved the trees even more.

For further analysis, an F-test was developed to compare the matrices generated by two nested trees to see if the fit improvement of their respective matrices was statistically significant. This analysis resulted in confirming that aaRS class did add significant improvement to trees that took into account other chemical properties.

14.11. Investigating rank-based approaches for inferring phylogenies

Joshua Stevenson (University of Tasmania)

16:50 Wed 4 December 2019 – 187

Mr Joshua Stevenson

Flattenings are matrices constructed using site-pattern counts from an alignment. These matrices provide a way of identifying 'true' *splits*, and hence the true evolutionary tree, via the evaluation of their rank. The size of these matrices, exponential in the number of taxa, introduces a computational challenge. This challenge led to the development of so-called *subflattenings* (Sumner, 2017), which exhibit analogous rank properties but have smaller dimensions (quadratic in the number of taxa). The construction of subflattenings involves representation theory and the application of a similarity transformation in which some choices are involved. This talk summarises my Honours thesis, which explores some algebraic concepts related to these matrices, and the practical implications of some possible choices in the construction of subflattenings.

14.12. The origins of heavy-tailed laws in biology

Michael Stumpf (The University of Melbourne)

13:30 Wed 4 December 2019 – 187

Prof Michael Stumpf

Fat tails and power law distributions have fascinated researchers from all disciplines, and have gained perhaps particular prominence in biology. Here I will look at this from a statistical physics perspective and discuss representative examples from biological networks and gene expression models and data. I will pay particular attention to different sources of noise and how they affect cellular states and our observations of cellular behaviour.

14.13. The Markov embedding problem from an algebraic perspective

Jeremy Sumner (University of Tasmania)

16:00 Wed 4 December 2019 – 187

Jeremy Sumner and Michael Baake

A Markov matrix is said to be embeddable if it admits a representation as the exponential of a rate (generator) matrix. Equivalently, a Markov matrix is embeddable if and only if it arises as a probability transition matrix for a (finite-state) continuous-time Markov chain. In this work, we revisit the Markov embedding problem from an algebraic perspective with a focus on model-specific variants; in particular, we take examples from nucleotide substitution models commonly used in phylogenetics. Algebraically, we show that the centralizer of the Markov matrix plays a pivotal role in controlling the solution space.

14.14. Symmetry and redundancy: choosing the right algebra for circular genome distance computations

Venta Terauds (University of Tasmania)

15:35 Wed 4 December 2019 – 187

Dr Venta Terauds

The maximum likelihood estimate of time elapsed (MLE) has many advantages over other estimates of evolutionary distance for circular genomes under rearrangement models. However, even when one utilises the representation theory of the symmetric group algebra to convert the combinatorial computations into matrix ones, the calculation of MLEs retains a factorial complexity.

We show that the appropriate theoretical setting for the MLE computations is in fact not the symmetric group algebra but a smaller algebra. By incorporating the symmetry of the genomes and the model into the structure of the algebra, we remove redundancy in the calculations and make a commensurate gain in efficiency.

15. Mathematics Education

15.1. Learning and Teaching in a Digital world

Joshua Capel (UNSW Sydney)

14:45 Wed 4 December 2019 – G60
Dr Joshua Capel

In the 1955 we were told 'The future is now' but despite this the future still keeps coming.

For a few years now the school of Mathematics and Statistics at UNSW has been replacing select classroom tutorials with so-called 'Online Tutorials'. These are content delivered through various online platforms like Numbas and MapleTA, and (at first glance) doesn't appear to involve a tutor at all.

More recently the school has trying out 'virtual tutorials', which are a more traditional tutorial setting but attended and participated through video conferencing software (blackboard collaborate).

In this talk I will discuss some of the challenges we faced learning and teaching in this brave new digital world, as well as some of the benefits and disadvantages.

15.2. Empowering, Engaging and Enhancing Students' Learning using a Pen-Enabled Tablet

Renu Choudhary (Auckland University of Technology)

16:25 Wed 4 December 2019 – G60
Dr Renu Choudhary

Using a pen-enabled tablet (PET) to teach Mathematics to pre-degree students has evolved my teaching process as I have not only been able to completely replace the whiteboard but have also been able to use physical teaching space flexibly. Unearthing the multifarious advantages of using PET in initial years and reflecting on its impact on students' learning has inspired me to explore new tools to further enhance their experience.

Two years ago, I started using a wireless connector to project my tablet, and this notably transformed the classroom dynamic. This allows students to contribute to the sessions by writing on the PET from the comfort of their desk, while it is projected in real-time. In this talk, I will focus on how I used a pen-enabled tablet to empower students, while actively engaging them with resources and peers to further enhance their learning experience. Besides some of my reflections, I will share students' comments and examples of their work to show the impact that technology can have on communicating mathematical ideas and knowledge.

15.3. Should I apply for a Teaching Award

Diane Donovan (The University of Queensland)

16:50 Wed 4 December 2019 – G60
Prof Diane Donovan

This session will be an open discussion with an opportunity to ask questions and share ideas with a panel of well known experienced mathematics educators, including Kumudini Dharmadasa, Deborah King, Anthony Morphett.

Each panel member will give a brief presentations on how they would structure an application, with a particular emphasis on evidencing and bench marking.

All members of the AustMS are encouraged to join this discussion.

15.4. Blended learning in a large first year mathematics course

Poh Hillock (The University of Queensland)

13:30 Wed 4 December 2019 – G60
Dr Poh Hillock

The UQ2U program at The University of Queensland aims to redevelop UQ's large courses to deliver more flexibility and high value on campus activities. In 2018, MATH1051 (Calculus and Linear Algebra I), our largest first year mathematics course (yearly enrolment of 1500) was selected for the UQ2U program. The project has resulted in the development of online resources delivered through the edge.edx platform, and the subsequent re-design of MATH1051. In this presentation, I describe the UQ2U MATH1051 journey, from the development of resources to implementation in Semester 1, 2019 and improvements made in Semester 2, 2019. I will share lessons learned, what worked, what didn't, and where we go from here!

15.5. Igniting interest, inspiration, investigation and intrigue within mathematics support.

Deborah Jackson (La Trobe University)

15:10 Fri 6 December 2019 – G60
Dr Deborah Jackson

Mathematics support centres can have different foci, targets and emphases, depending on what type of support is offered and how they are set up. Such support can simply be used for subject and assignment help and guidance. If promoted or managed in this manner, the student will come along with expectations that they need only solve their current problems and look no further. Eking out deep mathematics anxieties or skills deficiencies is often not part of a student's psyche, and many leave further learning to some other time or place, creating a danger of 'surface learning'. With such a scenario, a support centre can become dull and lifeless at certain times, and busy, cumbersome, and hectic at others. However, support centres can be much more than this. They can • encourage students to confront their inadequacies and do something about them,

• ignite interest in what mathematics is all about, and where it is used, • set out to intrigue students and encourage them to investigate, • motivate and inspire students to appreciate the real beauty of mathematics and how it has evolved through history. Support centres that manage to reach out past the norm become places where students can do more than solve subject specific problems. They can engage students in deep learning, discussion, and attention to detail. They can be places for providing rest and nurturing for the weary, and, at the same time, inspire the curious and intrigued. This talk discusses how we can make such support happen. Within a changing environment, where students need more support than ever, creating a future where mathematics support is a living and vibrant part of student learning is essential.

15.6. Peer assessment and feedback - in class and online

Simon James (Deakin University)

13:55 Wed 4 December 2019 – G60

Dr Simon James

Peer feedback has the potential to help engage students toward higher cognition thinking whether implemented in online environments or on-campus classrooms. I will reflect on my own experiences in anonymous online peer feedback for problem-solving portfolios as well as discussing what the literature has to say about some other models. Discussion and ideas will be welcome!

15.7. Assessment in First Year Mathematics

Jonathan Kress (University of New South Wales)

13:55 Fri 6 December 2019 – G60

Assoc Prof Jonathan Kress

Recent changes to first year mathematics courses at UNSW will be discussed. Comparable exam questions from before and after the change have been analysed with clear evidence of improvement in student achievement.

15.8. Can Kuhn revolutionise mathematics teaching?

Terence Mills (La Trobe University)

15:35 Fri 6 December 2019 – G60

Terence Mills and Aimé Sacrez

School students might be forgiven for thinking that once mathematical ideas are fixed, they are fixed forever. Mathematics is right or wrong. Yet, mathematicians know that this is not the whole story. In 1962 Thomas Kuhn introduced the term ‘paradigm shift’ to the philosophy of science. The purpose of this paper is to identify paradigm shifts that have occurred in mathematics, and discuss their relevance to school mathematics. Kuhn’s ideas can be used to promote awareness that mathematics adapts to different cultural-historical contexts. In the words of the Australian Curriculum, this will assist students, “to develop an understanding of the relationship between the ‘why’ and the ‘how’ of mathematics”. This paper was first presented as a Short Communication at the 42nd annual conference of the Mathematics Education Research Group of Australasia.

15.9. Can Comparative Judgement Improve Student Performance with Rational Inequalities?

Jennifer Palisse (The University of Melbourne)

14:20 Wed 4 December 2019 – G60

Jennifer Palisse

Comparative judgement is a process that has recently been used for assessing and ranking student work that has been difficult to assess using traditional methods such as rubrics or marking schemes. It involves an assessor being shown two pieces of work, from which they had to judge which is best. By completing a large number of judgements, a reliable ranking of student work can be obtained. Most research on comparative judgement in education has focused on whether it can be reliably used as an assessment tool for large scale exams, that is, whether an acceptable level of agreement exists between assessors. More recently, comparative judgement has included students as peer-assessors. While, comparative judgement is receiving increased interest as a learning tool (Jones & Inglis, 2015; Jones & Wheadon, 2015; Potter et al., 2017), very little is still known about how individuals make their decisions or whether the process can offer the assessor meaningful learning benefits. This presentation reports early findings from a study on the role comparative judgement might play in improving student performance and student understanding. The study involved first year mathematics students who were given a rational inequalities problem to solve. Early results suggest that the process of comparative judgement marginally improved the performance of some high-ability students but did little to resolve pre-existing misconceptions of low-ability students with no improvement in performance.

15.10. Making the Grade: Do Mathematics Marks Matter to Women in STEM

Jennifer Palisse (The University of Melbourne)

13:30 Fri 6 December 2019 – G60

Deborah King, Jennifer Palisse

The disparity between female and male participation in fields that are underpinned by mathematics, for example, science, engineering and technology, is well known and has been researched for decades. Although significant attention has been focused on redressing this imbalance and programs have been purposefully designed to encourage and support girls in Science, Technology, Engineering and Mathematics (STEM), the gender gap persists at all levels of education and in the workplace.

We discuss preliminary results of a study conducted at a high-ranking Australian university. Participants of the study were undergraduate students pursuing a major that required tertiary mathematics. The aim of the study was to determine if students' perceptions of their mathematics results impacted on their decision to continue with their current major.

While students' satisfaction with grades was linked to their commitment to their current major for both male and female students, differences between genders were found with female students significantly more sensitive to their perception of performance in the critical first-semester of university than their male peers, impacting negatively on their intention to persist with their major.

15.11. Mathematics Enrichment Program at UNE – from Primary School to University

Jelena Schmalz (University of New England)

16:00 Wed 4 December 2019 – G60

Dr Jelena Schmalz

At UNE we have started several non-curriculum maths activities during the recent two years, namely a Maths Club for primary school students, a website with mathematical puzzles and challenges for high school students, and a problem solving seminar for university students. In this talk we explain the aims and reasons for starting these initiatives, describe the activities, and the outcomes.

15.12. Does the Effectiveness of Mathematics and Statistics Support Depend on Students' Mathematical Background?

Donald Shearman (Western Sydney University)

14:20 Fri 6 December 2019 – G60

Donald Shearman, Gizem Intepe, Leanne Rylands

Learning support for mathematics and statistics is offered by most Australian universities. A number of studies have shown that there is a positive association between students' use of such support and student success in mathematics and statistics subjects. Relatively little research has been conducted into the role of confounding variables such as students' mathematical background on this association.

At Western Sydney University mathematics and statistics support is provided by a centrally organised unit, the Mathematics Education Support Hub (MESH). MESH offers both face-to-face and online support. The two main face-to-face support services are workshops held prior to major assessments for students taking first-year mathematics and statistics subjects; and one-to-one consultation sessions. Data about student use of both of these services is collected by MESH. We have been able to merge this data with university records including students' mathematical background, final subject marks and discipline.

Analysis of the data suggests that whilst use of support is associated with improved student outcomes, there are significant differences in the extent of improvement based on the students' mathematical background and the mode of support used. A surprising result of this analysis is the difference in improvement by students with no senior secondary school mathematics compared with those who undertake elementary level mathematics study in their final two years of secondary school.

16. Mathematical Physics, Statistical Mechanics and Integrable systems

16.1. Noncommutative Field Theory and Discrete Orthogonal Polynomials

Ciprian Sorin Acatrinei (National Institute for Nuclear Physics and Engineering)

16:00 Tue 3 December 2019 – G55

Dr Ciprian Sorin Acatrinei

Field theories defined on a non-commutative space allow for a natural discretization of their base space and consequently of their equations of motion. These involve, for example, Hahn polynomials in the case of S^2 non-commutativity. A study of the properties of such field theories together with a number of interesting mathematical questions they engender will be presented.

16.2. Selberg integrals and the AGT conjecture

Seamus Albion (The University of Queensland)

14:20 Wed 4 December 2019 – G55

Mr Seamus Albion

The Selberg integral is an important multidimensional analogue of Euler's beta integral first proved by Selberg in 1944. In their recent verification of the AGT conjecture for $SU(2)$, Alba, Fateev, Litvinov and Tarnopolskiy (AFLT) discovered a new generalisation of Selberg's integral with a pair of Jack polynomials inserted in the integrand. I will discuss a generalisation of the integral of Alba et al. for $SU(n)$, as well elliptic and q-analogues of the AFLT integral.

16.3. Semi-flexible polymers in a strip with attractive walls

Nicholas Beaton (The University of Melbourne)

15:10 Tue 3 December 2019 – G55

Dr Nicholas Beaton

I'll discuss a model of linear polymers in a two-dimensional strip. The polymers interact with the walls of the strip via two Boltzmann weights a, b, with an additional weight c which is used to control how flexible or stiff the polymers tend to be. This is a simple model of steric stabilisation, the process by which polymers can hold colloidal particles in solution. The model can be solved exactly, and we compute quantities like the force exerted by a polymer on the walls of the strip.

This is joint work with Jonathon Liu, Leo Li and Thomas Wong.

16.4. Escape estimates for SLE

Laurence Field (Australian National University)

15:10 Fri 6 December 2019 – G55

Dr Laurence Field

The Schramm-Loewner evolution (SLE) is a family of random non-crossing fractal curves that are the scaling limits of interfaces in several critical planar models in statistical mechanics, including percolation, the Ising model and the Gaussian free field. Escape estimates for SLE are uniform bounds on the probability that the curve escapes far from a target point given the curve so far, and can be used to study the spatial decomposition of SLE. I will discuss proofs of escape estimates for chordal, radial and two-sided radial SLE in the simple-curve phase using Brownian excursion measures (joint work with Greg Lawler), and will also mention the new techniques needed to extend the escape estimates into the non-simple phase.

16.5. Further random matrix fermi gas analogies

Peter Forrester (The University of Melbourne)

16:50 Wed 4 December 2019 – G55

Prof Peter Forrester

It's well known that the the ensemble of Gaussian Hermitian random matrices known as the GUE has many analogies with the quantum mechanical systems of free fermions on a line, confined by an harmonic trap. Less well known is that the corresponding d-dimensional fermi system also shares a number of analogies in relation to properties of its one body density. We will both review known results along these lines, providing new derivations, and identify extensions of these results.

16.6. A lattice model with the symmetry of the quantum toroidal gl_1 algebra

Alexandr Garbali (The University of Melbourne)

14:20 Fri 6 December 2019 – G55

Dr Alexandr Garbali

The quantum toroidal gl_1 algebra has an exciting representation theory and multiple connections to various problems in mathematical physics. An interesting direction is the study of the integrable model on the infinite dimensional Fock representation of this algebra. The central object in this model is the R-matrix. I will focus on the problem of calculation of this R-matrix.

16.7. Critical speeding up in dynamical percolation

Timothy Garoni (Monash University)

15:35 Fri 6 December 2019 – G55

Assoc Prof Timothy Garoni

We study the integrated autocorrelation time of the size of the cluster at the origin in critical dynamical percolation. We consider trees, high-dimensional tori, and boxes on the triangular lattice, and in each case show that the autocorrelation time is bounded above by a strictly sublinear function of the graph size. It follows that the cluster size at the origin in these models exhibits critical speeding-up, and noise sensitivity. The main tool used in the proofs is a theorem of Schramm and Steif bounding Fourier coefficients of functions on the discrete hypercube via properties of certain randomised algorithms. The resulting randomised algorithms may also be of direct practical use for Monte Carlo sampling. This is joint work with Eren Elci and Andrea Collevecchio.

16.8. Some recent developments in self-avoiding walks

Tony Guttmann (The University of Melbourne)

13:30 Wed 4 December 2019 – G55

Prof Tony Guttmann

Continuing my lifelong interest in this topic, I will discuss two recent calculations. (i) New scaling laws (joint work with B Duplantier). (ii) The SAW at the theta point on the hexagonal lattice (joint work with Nick Beaton and Iwan Jensen).

16.9. Alignment percolation

Mark Holmes (The University of Melbourne)

14:20 Tue 3 December 2019 – G55

Assoc Prof Mark Holmes

Perform site percolation with parameter p on the hypercubic lattice. From each occupied site look in the direction of the next occupied site, and declare the entire segment between them to be open (or closed) according to some rule (e.g. open independently with probability lambda). Is there an infinite cluster of interlocking open segments? This is joint with with Nick Beaton and Geoffrey Grimmett.

16.10. Large complex systems beyond the instability threshold

Jesper Ipsen (The University of Melbourne)

17:40 Wed 4 December 2019 – G55

Jesper Ipsen

More than 40 years ago, Australian ecologist and applied mathematician Robert May asked in a highly influential paper: "Will a large complex system be stable?" Using a fully random linearised model May showed that a generic complex system becomes unstable when the number of interacting components or the strength of the randomness reaches a certain threshold. However, due to the assumption of linearity May's model cannot say anything about the what happens beyond the instability threshold. In this talk we will address this regime though a fully random nonlinear model using techniques from the theory of Gaussian Random Fields and Random Matrices.

Based on work with Yan Fyodorov and Sirio Fedeli at King's College London.

16.11. Painlev'e VI in Okamoto's Space

Nalini Joshi (The University of Sydney)

13:55 Thu 5 December 2019 – G55

Viktoria Heu, Nalini Joshi, Milena Radnovic

The sixth Painlevé equation (P_{VI}) is a nonlinear differential equation with striking mathematical properties. It can be written as

$$w'' = \frac{1}{2}\left(\frac{1}{w} + \frac{1}{w-1} + \frac{1}{w-t}\right)w'^2 - \left(\frac{1}{t} + \frac{1}{t-1} + \frac{1}{w-t}\right)w' + \frac{w(w-1)(w-t)}{t^2(t-1)^2}\left(\alpha + \frac{\beta t}{w^2} + \frac{\gamma(t-1)}{(w-1)^2} + \frac{\delta t(t-1)}{(w-t)^2}\right),$$

where w is a function of t and α, β, γ, δ are parameters. In this talk, I will present our work on the dynamical properties of P_{VI} in its space of initial values, called Okamoto's space.

16.12. Matrix products involving Hermitian Random Matrices

Mario Kieburg (The University of Melbourne)

17:15 Wed 4 December 2019 – G55

Dr Mario Kieburg

Products of random matrices have been an important development in the recent years in random matrix theory. Their applications are versatile and reach from quantum transport in disordered systems to the stability analysis of complex systems and telecommunications. One open problem has been, how products involving symmetric spaces like Hermitian matrices have to be dealt with. Recently, I have solved this question by modifying the spherical transform approach introduced by Harish-Chandra et al. for groups. I will report on this development during my talk.

16.13. Spectral shift function via regularised determinant of higher order

Galina Levitina (University of New South Wales)

16:50 Tue 3 December 2019 – G55

Dr Galina Levitina

The original formula of M.G.Krein expresses spectral shift function for two self-adjoint operators via appropriate perturbation determinant. However, this formula is suitable for differential operators is lower dimensions only. We prove a formula of spectral shift function via regularised perturbation determinant, which is suitable for differential operators in all dimensions. As an example, we consider Dirac operator on $\mathbb{R}^d$.

16.14. On the global stability of Minkowski spacetimes in string theory

Makoto Narita (National Institute of Technology, Okinawa College)

15:35 Tue 3 December 2019 – G55

Prof Makoto Narita

We show a theorem of the global nonlinear stability of Minkowski spacetimes in the Einstein-Maxwell-dilaton-axion (EMDA) system. This system arises from a low energy effective theory in the heterotic superstring theory. The idea of Lindblad-Rodnianski's weak null condition is used in the proof. The theorem states that the EMDA equations in wave and Lorentz gauges with asymptotically flat initial data satisfying a smallness condition produce causally geodesically complete spacetimes asymptotically approaching to the Minkowski spacetimes.

16.15. The length of self-avoiding walks on the complete graph

Abrahim Steve Nasrawi (Monash University)

13:55 Wed 4 December 2019 – G55

Abrahim Nasrawi

We study the variable-length ensemble of self-avoiding walks on the complete graph. We obtain the leading order asymptotics of the mean and variance of the walk length, as the number of vertices goes to infinity. Central limit theorems for the walk length are also established, in various regimes of fugacity. Particular attention is given to sequences of fugacities that converge to the critical point, and the effect of the rate of convergence of these fugacity sequences on the limiting walk length is studied in detail. Physically, this corresponds to studying the asymptotic walk length on a general class of pseudocritical points.

16.16. The tropological vertex

Brett Parker (Monash University)

16:25 Tue 3 December 2019 – G55

Dr Brett Parker

I will discuss new symmetries determining the topological vertex of Aganagic, Kelm, Marino and Vafa. This topological vertex can be interpreted as encoding Gromov–Witten invariants, which count holomorphic curves (classical trajectories of strings in some versions of string theory.) We will see how to count these holomorphic using tropical curves, and the new symmetries of the topological vertex will have simple geometric interpretation in terms of tropical curves. This is joint work with Norm Do.

16.17. Conformal field theory and the non-abelian SU(2) level k chiral spin liquid

Thomas Quella (The University of Melbourne)

13:55 Fri 6 December 2019 – G55

Dr Thomas Quella

We construct a family of 1D and 2D long-range SU(2) spin models as parent Hamiltonians associated with infinite dimensional matrix product states that arise from simple current correlation functions in $SU(2)_k$ WZW models. It is also explained how the ground state wave function can be computed explicitly from a symmetrization procedure applied to k independent copies of $SU(2)_1$ WZW models.

16.18. Recursions on the Moments of Random Matrix Ensembles

Anas Abdur Rahman (The University of Melbourne)

15:35 Wed 4 December 2019 – G55

Mr Anas Abdur Rahman

Given a random matrix ensemble, one would like to investigate the moments of its eigenvalue density. Many ensembles have the property that the moments satisfy recursions, allowing for efficient computation. In this talk, I will introduce the aforementioned quantities and then outline two types of moment recursions that I'm currently interested in. The first is derived through the loop equation formalism which is related to topological recursion, and the latter is derived through Selberg correlation integrals and is comparable to the Harer-Zagier recursion. Particular attention will be given to the differences between the two types of recursions.

16.19. Quantum Entanglement, Schrodinger's cat, and the Q-function phase-space model of reality

Margaret Reid (Swinburne University of Technology)

13:30 Fri 6 December 2019 – G55

Prof Margaret Reid

In 1935, Einstein, Podolsky and Rosen (EPR) presented an argument for the completion of quantum mechanics. Their argument was based on the correlation properties of two spin ½ particles prepared in a singlet state. Such a state is said to be 'entangled'. Here, we first briefly outline the features of the EPR entangled states, explaining how this ultimately lead to Bell's theorem, which gave proof of the incompatibility between all classical local hidden variable theories and quantum mechanics, and to applications in the field of quantum information. Closely linked with EPR's argument is the paradox of Schrodinger's cat. In quantum theory, when a measurement is made, a macroscopic system interacts with a smaller quantum system to create an entangled state. The resulting 'Schrodinger cat-state' is a superposition of two macroscopically distinguishable states. The cat-state is apparently paradoxical because according to the standard interpretation of quantum mechanics, such a system cannot be regarded as being 'in one state or the other', prior to a measurement. We discuss the interpretation of the macroscopic Schrodinger cat-state and of the quantum measurement of a qubit system. Using an element of reality approach, we justify that the "collapse" of the state of the system to give one or other outcome occurs as a result of the amplification associated with the coupling to the macroscopic system, regardless of decoherence. We then explain how one might falsify macroscopic local realism, using Bell inequalities for macroscopic qubits. This motivates us to introduce a model of reality based on the phase space representation known as the Q function. In this picture, a physical universe exists in space-time without observers. The measurement is described by dynamical evolution where sharp eigenvalues emerge for sufficient amplification. We show how the model is not inconsistent with Bell's theorem, because of the backwards in time causation which occurs in Q-function dynamics through negative diffusion terms.

16.20. On the asymptotic distribution of roots of the generalised Hermite polynomials

Pieter Roffelsen (International School for Advanced Studies (SISSA))

14:20 Thu 5 December 2019 – G55

Davide Masoero, Pieter Roffelsen

The generalised Hermite polynomials $H_{m,n}$, $m, n \in \mathbb{N}$, form a family of polynomials with applications to random matrices, quantum mechanics and nonlinear wave equations. Central in each of these applications is the fact that these polynomials generate rational solutions of the fourth Painlevé equation. About fifteen years ago, Peter Clarkson published numerical investigations on the distributions of their roots in the complex plane and posed the problem of giving an analytic explanation of his numerical findings.

In this talk, I will show how the roots of generalised Hermite polynomials can be characterised in terms of an inverse monodromy problem concerning a class of anharmonic oscillators. A complex WKB approach to latter oscillators yields a uniform, asymptotic description of the bulk of the roots in terms of elliptic integrals as the degree $\deg(H_{m,n}) = m \times n$ grows large. The roots, after proper rescaling, densely fill up a bounded quadrilateral region in the complex plane and, within this region, organise themselves along a deformed rectangular lattice, yielding an asymptotic answer to Clarkson's problem.

This talk is based on two joint papers with Davide Masoero:

-Roots of generalised Hermite polynomials when both parameters are large, ArXiv, 2019;

-Poles of Painlevé IV Rationals and their Distribution, SIGMA, 2018.

16.21. Rolling, rolling, rolling

Katherine Anne Seaton (La Trobe University)

14:45 Wed 4 December 2019 – G55

Dr Katherine Anne Seaton

In this talk I will describe some results from an ongoing collaboration with an inventor. The construction and the features of intriguing 'new' solids (devised by David Hirsch) will be outlined. These solids roll in an amusing fashion, and are both mathematical art (kinetic sculptures) and mathematical physics.

16.22. Hierarchies of q-discrete second, third and fourth Painlevé equations and their properties

Dinh Tran (The University of Sydney)

13:30 Thu 5 December 2019 – G55

Ms Dinh Tran

In this presentation, we give hierarchies of q-discrete second, third and fourth Painlevé ($qP_{\mathrm{II}}, qP_{\mathrm{III}}, qP_{\mathrm{IV}}$) equations. These hierarchies were derived by using geometric reductions/ staircase reductions of a multi-parametric integrable lattice equation. Their Lax pairs can be obtained directly from the staircase reductions.

We then present a method to obtain Bäcklund transformations of the hierarchies systematically. The key ingredients for this method are the consistency around the cube property and the staircase reductions. We are able to recreate the known Bäcklund transformations for the first member of the $qPII$ hierarchy. Special q-rational solutions of the hierarchies are constructed and corresponding functions that solve the associated linear problems are derived.

We also study the symmetry groups of the hierarchies by using the geometric reductions.

This is joint work with H. D. Alrashdi and N. Joshi.

16.23. Finite size corrections at the hard edge for the Laguerre β ensemble

Allan Trinh (The University of Melbourne)

16:00 Wed 4 December 2019 – G55

Mr Allan Trinh

Universal laws of spectral statistics are central to random matrix theory. In addition to quantifying these laws in large N limit, there is a recent interest in establishing the optimal rate of convergence. In this talk, I'll introduce the classical Laguerre Unitary Ensemble and its β analogue. Asymptotic results up to the next finite N correction for the distribution of the smallest eigenvalue and the spectrum at the so called hard edge will be discussed.

16.24. Spherical transform and randomised Horn problem

Jiyuan Zhang (The University of Melbourne)

16:25 Wed 4 December 2019 – G55

Mr Jiyuan Zhang

The randomised Horn problem is to ask for the eigenvalue distribution of sum/product of two random matrices. Its simpliest analogue is sum of independent real random variables, which can be solved using univaraite Fourier transform. The generalisation from real variables to matrices requires us to specialise the well-established theory of spherical transform to spaces of random matrices. We will introduce spherical transforms for Herm(n), $\text{Herm}_+(n)$ and U(n), as well as their applications to randomised Horn problems on those spaces. Closed form expressions for the eigenvalue distributions are given, when one of the two random matrices has rank 1.

16.25. The coupling time of the Ising Glauber dynamics

Zongzheng Zhou (Monash University)

16:00 Fri 6 December 2019 – G55

Dr Zongzheng Zhou

Consider an ergodic Markov chain with n states. Run n chains simultaneously with distinct initial states but using the same randomness. There exists a non-negative random variable T_n such that starting at $-T_n$ the n chains will all have coalesced by time 0. It was proved by Propp and Wilson that sampling at time 0 is exactly stationary. This procedure is called "coupling from the past", and T_n is called the coupling time. In this talk, we will discuss a limit theorem for the distribution of the coupling time of a specific Markov chain: Glauber dynamics of the Ising model on d-dimensional tori. The infinite temperature case simply corresponds to the coupon collecting problem, for which Erdős and Rényi proved the standardised coupling time converges to a Gumbel distribution. In our work, we prove that a similar limit theorem holds down to a finite temperature.The proof relies on the compound Poisson approximation and the information percolation method.

17. Number Theory and Algebraic Geometry

17.1. Improvements to Dirichlet's theorem in Diophantine approximation

Ayreena Bakhtawar (La Trobe University)

16:25 Wed 4 December 2019 – G57

Miss Ayreena Bakhtawar

The starting point of the theory of Diophantine approximation is Dirichlet's theorem (1842) which studies the approximation properties of real numbers by rationals with the bounded denominators. In this talk, I will discuss some recent measure theoretic results regarding improvements to Dirichlet's theorem.

17.2. Explicit Pólya-Vinogradov for primitive characters and large moduli

Matteo Bordignon (University of New South Wales Canberra)

16:25 Tue 3 December 2019 – G57

Mr Matteo Bordignon

We obtain a new fully explicit constant for the Pólya-Vinogradov inequality for Primitive characters. Given a primitive character χ modulus q, we prove the following upper bound

$$\left|\sum_{1\le n\le N}\chi(n)\right| \le c\sqrt{q}\log q,$$

where $c = 3/(4\pi^2) + o_q(1)$ for even characters and $c = 3/(8\pi) + o_q(1)$ for odd characters, with an explicit $o_q(1)$ term. This improves a result of Frolenkov and Soundararajan for large q. We proceed, following the trace of a paper by Hildebrand, obtaining the explicit version of a result by Montgomery–Vaughan on Partial Gaussian sums and an explicit Burgess like result on convoluted Dirichlet characters, that simplifies Hildebrand's approach.

17.3. The etale fundamental group of semirings

James Borger (Australian National University)

13:30 Thu 5 December 2019 – G57

Dr James Borger

Grothendieck extended Galois theory from fields to rings in his theory of the etale fundamental group. In this talk, I'll explain how to extend this to semirings, as developed in Robert Culling's 2019 ANU PhD thesis. I'll also present his proof that the semiring of non-negative reals has trivial fundamental group, much as the complex numbers do (the fundamental theorem of algebra) and the integers do (Minkowski's theorem).

17.4. Explicit results on the sum of a divisor function

Michaela Cully-Hugill (University of New South Wales Canberra)

15:35 Wed 4 December 2019 – G57

Ms Michaela Cully-Hugill

We present an explicit bound on the partial sums of the divisor function, and areas where this result can be applied. An intermediate result concerning a different divisor function will also be given, as it implies a bound on the class number for quartic number fields. This is joint work with Tim Trudgian.

17.5. Burgess' Bound and kth Power Non-residues

Forrest James Francis (Australian Defence Force Academy)

15:35 Tue 3 December 2019 – G57

Mr Forrest James Francis

Let χ be a Dirichlet character modulo a prime p. Often, one requires estimates for "short" sums over this character. In this talk, we consider explicit versions of one of these estimates, a family as bounds referred to as the Burgess' bound. We'll look at some small improvements to the explicit constant in this bound, and their application to a problem involving kth power non-residues modulo p.

17.6. Lower order terms for the one level density of quadratic Hecke L-functions in the Gaussian field

Peng Gao (Beihang University)

13:30 Wed 4 December 2019 – G57

Prof Peng Gao

As the density conjecture of Katz and Sarnak relates the main term behavior of the n-level density of low-lying zeros of families of L-functions to random matrix theory, one can do more on the number theory side by computing the lower order terms of these n-level densities, which serve to provide us better understandings on the n-level densities. In this talk, we will present a result on the lower order terms of the 1-level density of low-lying zeros of quadratic Hecke L-functions in the Gaussian field. Assuming the Generalized Riemann Hypothesis, we obtain the lower order terms for even test functions whose Fourier transforms are being supported in $(-2,2)$. This is joint work with L. Zhao.

17.7. Biases, oscillations, and first sign changes in arithmetic functions

Shehzad Shabbirbhai Hathi (UNSW Canberra)

16:00 Wed 4 December 2019 – G57

Mr Shehzad Shabbirbhai Hathi

We will introduce the topic using Skewes' number: an upper bound for the first sign change of the function $\pi(x) - \mathrm{Li}(x)$. Similar questions can be asked in the case of other arithmetic functions like the Möbius function (and the closely related Liouville function). To this end, we will discuss the Mertens conjecture. While the conjecture implies the Riemann Hypothesis, it has been disproved. However, an explicit counterexample to the Mertens conjecture still eludes us. We will discuss the scope for improvement in the existing results.

17.8. On the zero-free region for the Dedekind zeta-function

Ethan Simpson Lee (UNSW Canberra)

17:15 Tue 3 December 2019 – G57
Mr Ethan Simpson Lee

Everyone knows and loves the Riemann zeta-function because of its connection to the distribution of prime numbers via the prime number theorem (1896). For analogous reasons, one should also appreciate the Dedekind zeta-function for its connection to the distribution of prime ideals via the Chebotarëv density theorem (1926). Therefore, we will study the Dedekind zeta-function in this talk.

17.9. The prime ideal theorem in noncommutative arithmetic

Sean Lynch (UNSW Sydney)

15:10 Tue 3 December 2019 – G57
A/Prof Daniel Chan & Mr Sean Lynch

An arithmetic order is a noncommutative analogue of the integers. In the early 1980s, Colin J. Bushnell and Irving Reiner published several papers on L-functions for arithmetic orders and used them to study the asymptotic behaviour of associated counting functions. Here we focus on the distribution of maximal left ideals in arithmetic orders. In particular, we present a method which yields an error term without directly appealing to L-functions.

17.10. Quartic Gauss sums and twisted reciprocity

Benjamin Moore (The University of Adelaide)

14:20 Wed 4 December 2019 – G57
Mr Benjamin Moore

In 1850, Mathias Schaar discovered an analytic proof of quadratic reciprocity. His proof involved, as an intermediate step, a remarkable identity between objects now known as Gauss sums. This identity was rediscovered by Landsberg in 1893 and is now known as the Landsberg-Schaar relation. Later research on Gauss sums focussed on evaluating more complicated Gauss sums than the quadratic ones appearing in the Landsberg-Schaar relation, but a complete solution is known only in the quartic case. We demonstrate that the quartic Gauss sums arise as a special case of twisted quadratic Gauss sums, and exploit this fact to prove an analogue of the Landsberg-Schaar relation for quartic Gauss sums.

17.11. A combinatoric proof of Jackson's summation

Thomas Morrill (UNSW Canberra)

13:55 Thu 5 December 2019 – G57
Dr Thomas Morrill

Overpartitions are a generalisation of integer partitions, developed that their combinatorics align nicely with the coefficients of q-hypergeometric series. Thus, weight-preserving bijections between overpartitions and related objects are sufficient to prove equality for their associated generating functions. Conversely, known series transformations suggest the existence of such bijections. We focus on the q-analog of Jackson's classical ${}_6F_5$ summation viewed through the lens of overpartition tuples and discuss implications for the theory of overpartition ranks.

17.12. On Selberg's zero density estimate and related results

Aleksander Simonic (University of New South Wales Canberra)

16:50 Tue 3 December 2019 – G57
Mr Aleksander Simonic

Bounds on $N(\sigma,T)$, where $N(\sigma,T)$ denotes the number of zeros $\rho = \beta + \mathrm{i}\gamma$ of the Riemann zeta-function $\zeta(s)$ with $\beta > \sigma$ and $\gamma \in (0,T]$, are known as zero density estimates. Explicit results of such kind are valuable in studying distribution of prime numbers. Recently, there have appeared explicit versions of classical zero density estimates $N(\sigma,T) \ll T$ and $N(\sigma,T) \ll T^{\frac{3}{8}(1-\sigma)}\log^5 T$. In this talk we will present explicit Selberg's estimate $N(\sigma,T) \ll T^{1-\frac{1}{4}(\sigma-\frac{1}{2})}\log T$, while related results, e.g., the second and the fourth power moments of $\zeta\left(\frac{1}{2}+\mathrm{i}t\right)$, will also be discussed.

17.13. When primes are just too hard. . .

Timothy Trudgian (UNSW Canberra)

16:00 Tue 3 December 2019 – G57
Dr Timothy Trudgian

. . . turn to square-free numbers! These include all primes and those numbers indivisible by squares of primes (e.g., 6, 10, 14, 15,. . .) and so are not 'too composite'. If problems involving primes are too hard then we must content ourselves with the square-frees: the crumbs from the table. I shall outline the state of play with square-free numbers and some recent work with Tomás Oliveira e Silva and Mike Mossinghoff.

17.14. Involutive property and irreducibility of theta correspondence

Chenyan Wu (The University of Melbourne)

14:20 Thu 5 December 2019 – G57
Dr Chenyan Wu

Theta correspondence plays a key role in the study of automorphic forms. We will give a brief introduction of the construction and derive some key properties of theta correspondence of unitary dual reductive pairs, such as an involutive property and irreducibility of first occurrence.

17.15. A relaxation of Goldbach's conjecture

Kam Hung Yau (University of New South Wales)

14:45 Wed 4 December 2019 – G57
Mr Kam Hung Yau

The Goldbach conjecture states that all even integer greater than two is a sum of two primes. Currently we do not have sufficient tools to prove this conjecture but we can obtain the following relaxation: Uniformly for small q, we obtain an estimate for the weighted number of ways a sufficiently large integer can be represented as the sum of a prime congruent to a modulo q and a square-free integer. Our method is based on the notion of local model developed by O. Ramaré and may be viewed as an abstract circle method. I will take about the history of the problem and an outline of the proof.

18. Optimisation

18.1. Zero Duality Gap via Abstract Convexity

Thi Hoa Bui (Federation University Australia)

15:10 Tue 3 December 2019 – 188

Ms Thi Hoa Bui

Every convex lower semicontinuous function is the upper envelope of a set of affine functions. Hence, in classical convex analysis, affine functions act as "building blocks" or a family "simpler functions". The central idea of abstract convexity approach is to replace this family of simpler functions (the linear and affine functions in classical convex analysis), by a different set of functions. These sets are called abstract linear, and abstract affine sets. Mimicking the classical setting, abstract convex functions are the upper envelopes of elements of a set of abstract affine functions.

By using this approach, we establish conditions for zero duality gap to the context of nonconvex and nonsmooth optimization using tools provided by the theory of abstract convexity.

18.2. Projection algorithms in wavelet construction as a feasibility problem

Neil Kristofer Dizon (The University of Newcastle)

16:25 Tue 3 December 2019 – 188

Mr Neil Kristofer Dizon

The construction of compactly supported and smooth multidimensional wavelets with orthogonal shifts and multiresolution structure has been recently recast as a many-set feasibility problem. The Douglas-Rachford method, together with other projection algorithms and their many-set extensions, has been successfully employed to solve this problem.

In this talk, we report numerical results on circumcentering reflection methods applied to the nonconvex feasibility problem of wavelet construction. Peculiar to the structure of constraints in this problem, we also introduce a constraint reduction reformulation for well-known projection algorithms to accelerate convergence.

18.3. A Progressive Hedging - Feasibility Pump for Stochastic Integer Programming

Andrew Craig Eberhard (RMIT University)

15:10 Fri 6 December 2019 – 188

Prof Andrew Craig Eberhard

Stochastic mixed-integer programming (SMIP) models are, in essence, large-scale mixed-integer programming (MIP) models in which the uncertain nature of the input parameters are modelled by means of discrete scenarios. The strategy of solving deterministic equivalents of SMIP models often proves to be unfruitful, since it encompasses converting into very large-scale MIP counterparts. A much more promising strategy consists of exploiting the particular structure that SMIPs present to develop specialised solution methods that can implicitly cope with their large-scale nature. Recent developments stemming from the employment of Lagrangian decomposition for SMIP have represented an important step towards developing specialised B&B methods for SMIP.

In this talk, we turn our focus to another important component for a B&B approach, in particular, methods that can generate feasible solutions and hence improve primal (upper) bounds. There are a number of fields in discrete optimisation where there have been developed heuristics that are motivated by ideas from feasibility methods. The most notable example is the "Feasibility Pump" used for finding good feasible solutions of a Mixed Integer Linear Program (MIP). This is a general method that does not exploit the special structure of SMIP and so suffers from the same problems of dimensionality as the deterministic equivalent. We will discuss a modified version of a penalty-based Gauss-Seidel method commonly used in stochastic programming that has strong theoretical properties for certain important sub-classes of Stochastic Integer Programs (SIP). In particular we will show that the modified algorithm avoids the pitfall associated with the large scale equivalent problem and always converges to a feasible point. Some computational experiments will also be presented.

18.4. Linear Programming Based Optimality Conditions for Long Run Average Optimal Control Problems

Vladimir Gaitsgory (Macquarie University)

14:20 Fri 6 December 2019 – 188

Prof Vladimir Gaitsgory

We will consider an infinite time horizon optimal control problem with time discounting and time averaging criteria. We will state results establishing that the Abel and Cesaro limits of the optimal value are bounded from above by the optimal value of a certain infinite-dimensional linear programming (IDLP) problem and that these limits are bounded from below by the optimal value of the corresponding dual IDLP problem. Using this fact and assuming that there is no duality gap, we will establish sufficient and necessary optimality conditions for the long-run-average optimal control problem in the general case when the limit optimal value may depend on initial conditions of the system. The talk is based on results obtained in collaboration with V. Borkar and I. Shvartsman.

18.5. On the strong minimum in optimal control. A view from variational analysis.

Alexander Ioffe (Technion, Israel Institute of Technology)
13:30 Fri 6 December 2019 – 188
Prof Alexander Ioffe

Among applications of variational analysis (and metric regularity theory in particular) to optimization one of the most important is connected with the possibility to equivalently reduce constrained problems to unconstrained minimization of sufficiently well organized functionals. It opens doors to a fairly new approach to the study of necessary optimality conditions that allows to substantially shorten and simplify proofs of known results and to get new results not detected earlier by traditional variational techniques.

In optimal control the unconstrained problem has a form of a Bolza problem of calculus of variations with, necessarily, nonsmooth integrand and off-integral term. In the talk I shall briefly describe how this approach works for a proof of the Pontryagin maximum principle and then tell about a new second order necessary condition for a strong minimum (which in particular implies a totally new second order condition for a strong minimum in the classical problem of calculus of variations). If time permits, I shall show that the new conditions may work when the known necessary conditions fail.

18.6. About the Radius of Metric Subregularity

Alexander Kruger (Federation University Australia)
14:20 Tue 3 December 2019 – 188
Asen L. Dontchev, Helmut Gfrerer, Alexander Y. Kruger, Jiří V. Outrata

There is a basic paradigm, called the *radius of well-posedness*, which quantifies the "distance" from a given well-posed problem to the set of ill-posed problems of the same kind. In variational analysis, well-posedness is often understood as a regularity property, which is usually employed to measure the effect of perturbations and approximations of a problem on its solutions. 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 various 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.

The research was supported by the Australian Research Council, project DP160100854

18.7. On the Projected Polar Proximal Point Algorithm

Scott Boivin Lindstrom (Hong Kong Polytechnic University)
14:20 Thu 5 December 2019 – 188
Dr Scott Boivin Lindstrom

The Projected Polar Proximal Point Algorithm was recently introduced by M.P. Friedlander, I. Macedo, and T.K. Pong for solving convex optimization problems through gauge duality. We introduce the basic concepts and provide answers to several open questions about its convergence properties. In particular, we characterize its set of fixed points, and we prove strong convergence to a fixed point.

18.8. Minimizing Control Volatility for Nonlinear Systems with Smooth Input Signals

Ryan Loxton (Curtin University)
16:50 Tue 3 December 2019 – 188
Prof Ryan Loxton

We consider a class of nonlinear optimal control problems in which the aim is to minimize control variation subject to an upper bound on the system cost. This idea of sacrificing some cost in exchange for less control volatility, thereby making the control signal easier and safer to implement, is explored in only a handful of papers in the literature, and then mainly for piecewise-constant (discontinuous) controls. In this talk, we consider the case of smooth continuously differentiable controls, which are more suitable in several applications, including robotics and motion control. In general, the control signal's total variation, which is the objective to be minimized in the optimal control problem, cannot be expressed in closed-form. Thus, we introduce a smooth piecewise-quadratic discretization scheme and derive an analytical expression, which turns out to be rational and non-smooth, for computing the total variation of the approximate piecewise-quadratic control. This leads to a non-smooth dynamic optimization problem in which the decision variables are the knot points and shape parameters for the approximate control. We then present results showing that this non-smooth problem can be transformed into an equivalent smooth problem, which is readily solvable using standard optimization techniques.

18.9. Strong Valid Inequalities Identification for Mixed Integer Programs with a given Set of Solutions

Asghar Moeini (Curtin University)
15:35 Tue 3 December 2019 – 188
Dr Asghar Moeini

The characterization of strong valid inequalities for integer and mixed-integer programs is more of an artistic task than a systematic methodology, requiring inspiration that can sometimes be elusive. Frequently, this task is facilitated by somehow exploiting the structure of problems for devising strong valid inequalities. Subsequently, various mathematical techniques are utilized for proving that those inequalities, which are often easily shown to be valid, are indeed strong in the sense that they represent facets or other high dimensional faces. This paper develops a method to assist modelers in the challenge to devise strong valid inequalities. In each iteration, the proposed algorithm generates a valid inequality by solving a suitably constructed linear mixed integer program and applies some quality criteria in order to determine if it is a new strong valid inequality. To illustrate the proposed algorithm, a new Traveling Salesman Problem (TSP) formulation is developed based on a set of constraints already constructed in the context of the Hamiltonian Cycle Problem (HCP), and then the proposed algorithm is employed to derive a set of strong inequalities to tighten this TSP formulation. Finally, a comparison study between the relaxation of the new TSP formulation and that of a state-of-the-art TSP formulation is conducted. The computational study confirms the effectiveness of the devised inequalities due to the better quality of the relaxation provided by the new formulation.

18.10. Characterizations of Robinson regularity properties of implicit multifunctions and applications

Cuong Nguyen Duy (Federation University Australia)
16:00 Tue 3 December 2019 – 188
Nguyen Duy Cuong, Alexander Kruger

In this talk, we discuss primal and dual sufficient conditions for Robinson regularity properties of implicit multifunctions in normed (in particular, Banach/Asplund) spaces. These results are presented in terms of slopes and Clarke/Fréchet subdifferentials and normals. These types of conditions are often overlooked depsite appearing implicitly in proofs of many satements in the literature. We make an attempt to present the conditions explicitly. Interestingly, we prove that these conditions become necessary for the properties in the convex setting. As applications, we establish primal and dual characterizations of the conventional metric regularity properties of set-valued mappings as well as stability properties of a solution mapping of a semi-infinite multiobjective optimization problem.

18.11. A linear programming approach to approximating the infinite time reachable set of strictly stable linear control systems

Janosch Rieger (Monash University)
15:35 Fri 6 December 2019 – 188
Prof Andreas Ernst, Prof Lars Grüne, Dr Janosch Rieger

We develop a new numerical method for approximating the infinite time reachable set of strictly stable linear control systems. By solving a linear program with constraints that incorporate the system dynamics, we compute a polytope with fixed facet normals as an outer approximation of the limit set. In particular, this approach does not rely on forward iteration of finite-time reachable sets.

18.12. Optimal selling mechanism design in the presence of budget constraints

Vera Roshchina (UNSW Sydney)
16:25 Fri 6 December 2019 – 188
Dr Vera Roshchina

A seller would like to sell a range of goods in a way to maximise revenue. Each buyer has a type encoded by a valuation function and a budget constraint. The seller only knows the buyers' types and their (probability) distribution.

We focus on the discrete setting where the numbers of goods and buyers are finite. An optimisation formulation of this problem happens to have a discontinuous objective, linear on non-convex regions with tropical boundary. The structure of the problem allows for the design of an algorithm that solves it to optimality, however we are only able to resolve very small instances due to combinatorially inefficient enumeration step.

I will give a brief overview of the problem from the economics perspective, describe the structure of the optimisation formulation, explain our algorithm and the challenges that so far prevented us from designing a more efficient solution. It would be interesting to figure out the true complexity of this problem, and to see if there is a way to improve the efficiency of the numerical approach.

This talk is based on collaborative work with Sabrina Deo and Juan Carlos Carbajal (both at UNSW Sydney).

18.13. Certifying polynomial nonnegativity via hyperbolic optimisation

James Saunderson (Monash University)
13:55 Thu 5 December 2019 – 188
Dr James Saunderson

A key connection between real algebraic geometric and optimisation is that we can check whether a multivariate polynomial is a sum of squares by solving a semidefinite optimisation problem. This talk will focus on an alternative approach to certifying the nonnegativity of homogeneous multivariate polynomials that is based on the theory of hyperbolic polynomials, and can be made effective by solving hyperbolic optimisation problems. I will introduce this approach and discuss known relationships between these hyperbolic certificates of nonnegativity and sums of squares. On the way, I'll touch on why it is NP-hard to decide hyperbolicity of cubics, and exhibit the first explicit example of a hyperbolic cubic for which no power has a definite determinantal representation.

18.14. Remez method applicability in Chebyshev approximation problems

Nadia Sukhorukova (Swinburne University of Technology)

13:30 Thu 5 December 2019 – 188
Dr Nadia Sukhorukova

In this presentation I will talk about the application of Remez algorithm, originally designed for polynomial approximation, to a wider class of problems. Some of these problems can be considered as natural extensions of the classical polynomial approximations, while some others are application driven. One application area is signal clustering and signal processing.

18.15. Stochastic Variational Inequalities, Nash Equilibria under Uncertainty, and the Progressive Hedging Algorithm

Jie Sun (Curtin University)

17:15 Tue 3 December 2019 – 188
Prof Jie Sun

The concept of a stochastic variational inequality has recently been extended to a format that covers, in particular, the optimality conditions for multistage stochastic programming and Nash equilibrium problems. This extension may have great impact on solving stochastic optimization and equilibrium problems. One of the long-standing methods for solving such optimisation problems is the progressive hedging algorithm. That approach is demonstrated here to be applicable also to solving multistage stochastic variational inequality problems under monotonicity. Stochastic complementarity problems are presented as a special case and explored numerically in a linear two-stage formulation.

18.16. Best chebyshev approximation by rational functions

Julien Ugon (Deakin University)

16:00 Fri 6 December 2019 – 188
Dr Julien Ugon

In this presentation we will review some results on approximation by rational functions. We will provide an alternation theorem, and show how this type of approximation fits within a more general Chebyshev approximation framework.

19. Probability Theory and Stochastic Processes

19.1. Limit theorems for filtered long-range dependent random fields

Tareq Alodat (La Trobe University)

17:15 Wed 4 December 2019 – 183

Mr Tareq alodat

We investigate 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 $H \in (0.5, 1)$. In this work we also obtain convergence for the case $H \in (0, 0.5)$ and show how the Hurst parameter H can depend on the shape of the observation windows. Various examples are presented.

19.2. Yaglom Limit for Stochastic Fluid Models

Nigel Bean (The University of Adelaide)

15:35 Fri 6 December 2019 – 183

Prof Nigel Bean

In this paper we provide the analysis of the limiting conditional distribution (Yaglom limit) for stochastic fluid models (SFMs), a key class of models in the theory of matrix-analytic methods. So far, transient and stationary analysis of SFMs only has been considered in the literature, while limiting conditional distributions are only known for a limited class of stochastic models.

The crucial idea is to show equivalence of a singularity of a key matrix in SFM theory with the intersection of the spectra of two other key matrices. We then exploit the Heaviside principle to deduce the form of the limiting conditional distribution.

In this talk I'll show the audience some highlights of this journey.

19.3. Novel Methods for Model Selection in Linear Regression

Zdravko Botev (University of New South Wales)

13:55 Wed 4 December 2019 – 183

Dr Zdravko Botev

In this talk we explain how lasso-type model selection methods can sometimes fail using a few simple stylistic examples. Using Bayesian ideas of regularization, we suggest a simple remedy that, at least in the examples we tested, significantly improved the identification of the correct model.

19.4. Strongly Vertex-Reinforced Jump Processes localizes on 3 points

Andrea Collevecchio (Monash University)

17:15 Tue 3 December 2019 – 183

Dr Andrea Collevecchio

We study Vertex-Reinforced Jump Processes on the line. We prove that under strong reinforcement, the process localizes on exactly 3 points.

19.5. On some asymptotics of functionals of long-range dependent random fields.

Illia Donhauzer (La Trobe University)

16:50 Wed 4 December 2019 – 183

Mr Illia Donhauzer

We will discuss random fields possessing long-range dependence. We consider nonlinear integral functionals of the homogeneous isotropic Gaussian random field with long-range dependence

$$\int_{\Delta(rt^{\frac{1}{n}})} H_m(\xi(x))\,dx, r \to \infty$$

where H_m is a Hermite polynomial of rank m, $\xi(x)$ is a long-range dependent homogeneous isotropic Gaussian random field and $\Delta \in \mathbb{R}^n$ is an observation window, $\Delta(rt^{\frac{1}{n}})$ is a homothetic image of Δ with a coefficient $rt^{\frac{1}{n}}$.

Limits of these functionals are random processes represented by the Wiener-Ito integrals. Limit processes have different properties depending on the geometrical properties of the observation window Δ and its dimensionality n. It is known that in the one-dimensional case, the limit processes have the property of the stationarity of increments for all observation windows Δ. We study properties of the limit processes depending on the observation windows Δ in the multidimensional case.

19.6. Local Brownian Motions

Jie Yen Fan (Monash University)

15:35 Wed 4 December 2019 – 183

Ms Jie Yen Fan

In this talk, I will introduce local Brownian motions, which are processes that behave like a Brownian motion within a proximity of time, for any time. Constructions of such processes and some properties will be given. Joint work with Eduard Biche, Kais Hamza and Fima Klebaner.

19.7. Brownian motion in multiply connected planar domains

Laurence Field (Australian National University)

16:25 Wed 4 December 2019 – 183

Dr Laurence Field

In recent years the relevance of Brownian motion to questions of conformal mapping has become more visible. The uniformisation of finitely connected domains to certain classes of canonical reference domains is a classical result of Koebe. One such class is the half-plane minus points and horizontal slits, and the corresponding uniformising maps have been reinterpreted by Lawler in terms of excursion-reflected Brownian motion, a Markov process that is Brownian motion while inside the domain with a certain reflection condition at each boundary component. Drenning also showed that ERBM can also be used to analyse Loewner equations in multiply connected domains. I will discuss these results and possible extensions to other classes of reference domains.

19.8. Poisson-Dirichlet and Ewens sampling formula approximations for Wright-Fisher models

Han Gan (Northwestern University)

16:00 Tue 3 December 2019 – 183

Han Gan, Nathan Ross

The Poisson-Dirichlet distribution is a probability measure on the infinite dimensional ordered simplex, and its applications appear in a wide variety of applications in combinatorics, population genetics and Bayesian nonparameterics, to name a few. It is also intricately related with the celebrated Ewens sampling formula. In this talk we will give error bounds in the approximation of the frequencies of types for the Wright-Fisher model with infinite alleles mutation structure. This will also lead to a bound on the error between the distribution of the partition generated from sampling from a Wright-Fisher model and the Ewens sampling formula.

19.9. Forward and Backward in time. Population Genetics Stochastic Process Models

Robert Charles Griffiths (Monash University)

15:10 Tue 3 December 2019 – 183

Prof Robert Charles Griffiths

Classical stochastic process models in population genetics describe how a population of genes evolves forward in time under random drift, mutation, selection and recombination. Examples are the Wright-Fisher diffusion process; Moran models, which are birth and death processes; and Lambda-Fleming-Viot models, which are jump processes. Coalescent models, which are random trees or graphs, describe the ancestral lineages of samples of genes back in time. These backward and forward models belong together technically as dual stochastic processes. This talk will discuss examples of these pairs of forward and backward in time models.

19.10. Matching marginals and sums

Kais Hamza (Monash University)

14:45 Wed 4 December 2019 – 183

Assoc Prof Kais Hamza

For a given set of random variables $X_1,\ldots,X_d$ we seek as large a family as possible of random variables $Y_1,\ldots,Y_d$ such that the marginal laws and the laws of the sums match: $Y_i \overset{d}{=} X_i$ and $\sum_i Y_i \overset{d}{=} \sum_i X_i$. Under the assumption that $X_1,\ldots,X_d$ are independent and belong to any of the Meixner classes, we give a full characterisation of the random variables $Y_1,\ldots,Y_d$ and propose a practical construction by means of a finite mean square expansion. When $X_1,\ldots,X_d$ are identically distributed but not necessarily independent, using a symmetry-balancing approach we provide a universal construction with sufficient symmetry to satisfy the more stringent requirement that, for any symmetric function g, $g(Y) \overset{d}{=} g(X)$.

This is joint work with Robert Griffiths.

19.11. The asymptotic behaviour of the time-varying supermarket model

Hermanus Marinus Jansen (The University of Queensland)

15:10 Fri 6 December 2019 – 183

Mr Hermanus Marinus Jansen

In the supermarket model, there are n parallel servers, each having its own queue. Arriving customers select d queues at random and join the shortest among them. Much is known about this model if its parameters are constant, but it is not clear how it behaves if the arrival rate varies throughout the day, for instance. In this talk, we take a closer look at the supermarket model with time-varying parameters under the Join-the-Shortest-Queue policy (the special case in which $d = n$). We explore in particular how the time-varying nature of the parameters influences this model on the diffusion scale as the number of servers becomes large.

19.12. Effect of small noise leading to random initial conditions in dynamical systems

Fima Klebaner (Monash University)

13:55 Fri 6 December 2019 – 183

Prof Fima Klebaner

We study small random perturbations of non-linear dynamics in the vicinity of an unstable fixed point. The classical result on small random perturbations states that the effect of noise on a smooth dynamical system on any finite time interval $[0,T]$ vanishes in the limit as the ϵnoise converges to zero. But this is not the case when time intervals increase to infinity, eg. $T = c\log(1/\epsilon)$. The resulting approximation is the corresponding deterministic curve that starts at a random initial condition of the form $H(W)$. W

is the large time limit of the scaled linearized stochastic dynamics, and H is a limit of the deterministic non-linear flow $H(x) = \lim_{t\to\infty}\phi_t(xe^{-at})$. In the context of ergodic processes, this gives a complimentary result on the cut-off phenomena at criticality. This result has applications in biology, such as PCR and mutations, as well as in physics.

19.13. Interpretation of approximations to infinitesimal generators as Quasi-Birth-and-Death-like processes

Angus Hamilton Lewis (The University of Adelaide)

14:20 Tue 3 December 2019 – 183

Mr Angus Hamilton Lewis

A stochastic fluid process is a two dimensional Markov process $(J(t), X(t))$, where $J(t)$ is a continuous-time Markov chain known as the phase process, and $X(t)$ is a process with linear increments driven by $J(t)$. It is well known that the joint probability mass/density of the fluid model evolves according to a PDE. By applying the Discontinuous-Galerkin (DG) method to this PDE we can approximate the evolution of probability density over time. Perhaps more interestingly, the DG method also approximates the infinitesimal generator of the fluid model, which we can then use to analyse more complex models. The key feature is that the DG method is able to track both the phase and the level variables jointly. As a possible means for analysing these DG approximations, we show how the DG approximation to the generator of the fluid model can be viewed as a Quasi-Birth-and-Death-like process.

19.14. Positivity Preserving Numerical Schemes for Jump-extended CIR/CEV Process

Libo Li (University of New South Wales)

14:20 Wed 4 December 2019 – 183

Libo Li

We propose a positivity preserving implicit Euler—Maruyama scheme for a jump-extended constant elasticity of variance (CEV) process where the jumps are governed by a compensated spectrally positive alpha-stable process for alpha in (1,2). Different to the existing positivity preserving numerical schemes for jump-extended CIR or CEV process, the model considered here has infinite activity jumps. For this specific model, we calculate the strong rate of convergence.

19.15. Multivariate Lévy-driven Ornstein-Uhlenbeck processes Using Weak Subordination

Kevin Lu (Australian National University)

16:00 Wed 4 December 2019 – 183

Kevin Lu

Weak subordination is an operation that creates time-changed Lévy processes while allowing the subordinate to have dependent components. Based on recent results on self-decomposability of these processes, and focusing specifically on the weak variance alpha-gamma process, which is a multivariate generalisation of the variance gamma process using weak subordination, we construct Lévy-driven Ornstein-Uhlenbeck processes with the weak variance alpha-gamma process as the driving process or as the marginal distribution. Such processes incorporate autocorrelation and have applications in the financial modelling of stationary series. Specifically, we study calibration for the stationary solution of these Lévy-driven Ornstein-Uhlenbeck processes based on discrete-time observations. We derive a likelihood function using Fourier inversion, develop a stepwise procedure for estimation, and highlight our results in a simulation study. This extends the work of Valdivieso, Schoutens, Tuerlinckx (2009) to the multivariate setting.

19.16. Weak Subordination of Lévy processes on Hilbert spaces

adam nie (Australian National University)

17:40 Tue 3 December 2019 – 183

Mr Adam Nie

Let (X, T) be a pair of Lévy processes on $\mathbb{R}^d$ where T is a multivariate subordinator. It is known that the strong subordination of (X, T), i.e. the composition $X(T(t)) := \sum_n X_n(T_n(t))e_n$, does not in general produce another Lévy process, unless for example X has independent components or all T_n's are indistinguishable. The weak subordination, constructed by Buchmann, Lu and Madan, introduces another operation $X \odot T$ on (X, T) which produces a Lévy process that generalises traditional subordination in very intuitive ways.

We extend this construction to an infinite dimensional setting where X takes values in an arbitrary separable Hilbert space H. We define and characterise subordinators on the positive cone of a weighted sequence space $\ell_{1,w}$ with weights decreasing to zero, and give conditions for the law of T to concentrate on the sub-cone ℓ_∞^+. We then give sufficient conditions for a measure defined on the Borel sets of $H \oplus \ell_\infty^+$ to be a Lévy measure, which is then used to show the weak subordination $X \odot T$ produces another Lévy process. The characteristic triplet of the process $X \odot T$ is shown to be a direct generalization of Buchman et al.

19.17. Stochastic hyperbolic diffusion equations on the sphere

Andriy Olenko (La Trobe University)

14:20 Fri 6 December 2019 – 183

Prof Phil Broadbridge, Dr Andriy Olenko

We introduce stochastic fields generated by partial differential equations on the unit sphere. The Cauchy problem for a hyperbolic diffusion equation with random initial conditions is studied. The exact solution in terms of a series expansion is given. An approximation to the solution is provided and analysed by finitely truncating the series expansion. The upper bounds for the convergence rates of the approximation errors are derived. Smoothness properties of the solution and its approximation are investigated. It is demonstrated that the sample Holder continuity of this spherical random field is related to the decay of the angular power spectrum. Numerical studies of approximations to the solution and applications to real data are presented to illustrate the theoretical results.

The presentation is based on recent joint results with A.D.Kolesnik and N.Leonenko.

19.18. Non-central asymptotics for functionals of strong-weak dependent vector random fields

Dareen Omari (La Trobe University)

13:30 Wed 4 December 2019 – 183

Mrs Dareen Omari

In various applications researchers often encounter cases involving dependent observations over time or space. Dependence properties of a random process are usually characterised by the asymptotic behaviour of its covariance function. The available literature, except a few publications, addresses limit theorems and reduction principles for functionals of weakly or strongly dependent random fields separately. For scalar-valued random fields it is sufficient as such fields can exhibit only one type of dependence. However, for vector random fields there are various cases with different dependence structures of components. Such scenarios are important when one aggregates spatial data with different properties. For example, brain images of different patients or GIS data from different regions. We consider functionals of vector random fields which have both strongly and weakly dependent components. The main results demonstrate that the asymptotic behaviour of such functionals is not necessarily determined by their Hermite ranks. As an application of the new reduction principle we provide some limit theorems for vector random fields. In particular, we show that it is possible to obtain a non-Gaussian behaviour for the first Minkowski functional of the Student random field built on different memory type components.

19.19. Exponential decay for the exit probability from slabs of random walk in random environment

Alejandro Francisco Ramirez (Catholic University of Chile)

16:25 Tue 3 December 2019 – 183

Prof Alejandro Francisco Ramirez

It is believed that in dimensions $d \geq 2$ any random walk in an i.i.d. uniformly elliptic random environment (RWRE) on Z^d which is directionally transient is ballistic. In 2001 and 2002 Sznitman introduced the ballisticity conditions (T) and (T'), as a way to quantify the gap which would be needed to prove affirmatively this question. The first one is the requirement that certain unlikely quenched exit probabilities from a set of slabs decay exponentially fast with their width L. The second one is the requirement that for all $\gamma \in (0,1)$ the decay is like $\exp(-CL\gamma)$ for some $C > 0$. In this talk we present a proof of a conjecture of Sznitman of 2002, stating that (T) and (T') are equivalent. This is a joint work with Enrique Guerra.

19.20. A model for cell proliferation in a developing organism

Peter Taylor (The University of Melbourne)

13:30 Fri 6 December 2019 – 183

Phil Pollett, Peter Taylor and Laleh Tafakori

In mathematical biology, there is a great deal of interest in producing continuum models by scaling discrete agent-based models, governed by local stochastic rules. We shall discuss a particular example of this approach: a model for the way in which the neural crest cells that make up the enteric nervous system proliferate along a growing gut. Our starting point is a discrete-state, continuous-time Markov chain model proposed by Hywood, Hackett-Jones and Landman.

We exploit the relationship between the above-mentioned Markov chain model and the well-known Yule-Furry process to derive the exact form of the scaled version of the process. We use this to provide expressions for features of the occupancy process, such as the expected value and variance of the marginal occupancy at a particular site, the distribution of the mass of domain agents located up to any given point in the domain as well as limiting results for the above measures.

19.21. Information percolation and the coupling time of the stochastic Ising model

Zongzheng Zhou (Monash University)

16:50 Tue 3 December 2019 – 183

Dr Zongzheng Zhou

In this talk, we will discuss the running time of a coupling-from-the-past algorithm of the stochastic Ising model. There is a parameter β in the Ising model which is for controlling the strength of dependence. When $\beta = 0$ (zero dependence), the running time simply corresponds to a coupon collecting time, for which Erdős and Rényi proved that the standardised running time converges to a Gumbel distribution. In our work, we proved that a similar limit theorem holds up to a finite positive β. The proof relies on the compound Poisson approximation and an information percolation method.

20. Representation Theory

20.1. Classification of blocks in category O

Kevin Coulembier (The University of Sydney)

13:55 Wed 4 December 2019 – G62

Dr Kevin Coulembier

Work of Jantzen, Soergel and others established many equivalences between blocks in category O for semisimple Lie algebras. By developing techniques related to quasi-hereditary algebras and Bruhat orders we will turn those results into a full classification of blocks in category O up to equivalence.

20.2. Classification of relaxed highest-weight modules for admissible level Bershadsky-Polyakov algebras

Zachary Fehily (The University of Melbourne)

14:45 Wed 4 December 2019 – G62

Zachary Fehily

In this talk, I will present some general features of the representation theory of vertex operator algebras (VOAs) and the construction of W-algebras by quantum Hamiltonian reduction. Then I will describe some of my recent progress in understanding the representations of the admissible-level Bershadsky-Polyakov algebras. This constitutes a class of non-rational W-algebras where representations, characters and modular transformations are within reach. These results will also assist in understanding the representations underlying the admissible-level WZW models associated with sl_3.

20.3. Geometric Langlands for Wild Hypergeometric Sheaves

Masoud Kamgarpour (University of Queensland)

15:35 Wed 4 December 2019 – G62

Dr Masoud Kamgarpour

One of the main goals of the geometric Langlands program is to associate to every local system on a smooth curve, a Hecke eigensheaf on the moduli of bundles, equipped with appropriate level structures. When the curve is complete (the so called unramified case), the existence of the Hecke eigensheaf was established by Deligne, Drinfeld, Laumon, and Frenkel–Gaitsgory–Vilonen. However, there has been little progress in the ramified case.

Hypergeometric sheaves are important classes of ramified local systems. Their origin traces back to the seminal work of Riemann on Gauss's hypergeometric function. In modern times, the subject of hypergeometric sheaves was rejuvenated by Katz. In this talk, I will explain how one can explicitly construct the Hecke eigensheaf associated to wildly ramified hypergeometric sheaves. The key tool we use is Yun's notion of rigid automorphic data.

Based on joint work with Lingfei Yi.

20.4. Cohomology of line bundles on flag varieties

Linyuan Liu (The University of Sydney)

16:50 Wed 4 December 2019 – G62

Dr Linyuan Liu

The cohomology of line bundles on flag varieties is a natural and important object in the representation theory of reductive algebraic groups. I will first talk about the theory in characteristic zero and some previous results in positive characteristic. Then I will talk about the results obtained in my thesis for the three dimensional flag variety in positive characteristic, which is the first non-trivial case.

20.5. A gallery model for affine flag varieties

Yusra Naqvi (The University of Sydney)

17:15 Wed 4 December 2019 – G62

Elizabeth Milićević, Yusra Naqvi, Petra Schwer and Anne Thomas

Positively folded galleries arise as images of retractions of minimal galleries in Bruhat-Tits buildings and they play a role in many areas of maths including the study of affine Hecke algebras, Macdonald polynomials, MV-polytopes, and affine Deligne-Lusztig varieties. In this talk, we will define positively folded galleries and then look at a new recursive description of the set of end alcoves of these galleries, giving us a combinatorial description of certain double coset intersections in the affine flag variety.

20.6. Representations of affine vertex algebras: beyond category $\mathscr{O}$

David Ridout (The University of Melbourne)

14:20 Wed 4 December 2019 – G62

Dr David Ridout

Affine vertex algebras are among the best-studied examples of their kind. However, these studies usually focus on their highest-weight modules. Recent advances in physics, namely in logarithmic conformal field theory and the 4d-2d correspondence with supersymmetric gauge theories, show that highest-weight modules are not sufficient for these applications. I shall present an approach based on Mathieu's twisted localisation functors and coherent families that allows one to classify all weight modules (with finite-dimensional weight spaces) for an arbitrary affine vertex algebra, if the highest-weight classification is already known.

Joint work with Kazuya Kawasetsu.

20.7. Contravariant forms on Whittaker modules

Anna Romanov (The University of Sydney)

13:30 Wed 4 December 2019 – G62

Dr Anna Romanov

Let $\mathfrak{g}$ be a complex semisimple Lie algebra. Contravariant forms are symmetric bilinear forms on $\mathfrak{g}$-modules which are invariant under the transpose antiautomorphism of the Lie algebra. Many well-studied classes of $\mathfrak{g}$-modules, such as Verma modules and irreducible finite-dimensional modules, admit a unique contravariant form up to scaling. In the 1970s, Kostant introduced a class of $\mathfrak{g}$-modules which naturally generalize Verma modules called Whittaker modules. These modules are irreducible and infinite-dimensional. Unlike Verma modules, Kostant's Whittaker modules admit many linearly independent contravariant forms. In this talk, I'll describe joint work with Adam Brown which establishes that the dimension of the space of all contravariant forms on such a module is given by the cardinality of the Weyl group.

20.8. Crystal structures for canonical Grothendieck functions

Travis Scrimshaw (The University of Queensland)

17:40 Wed 4 December 2019 – G62

Dr Travis Scrimshaw

To describe the K-theory ring of the Grassmannian, Grothendeick polynomials are the basis corresponding to Schubert varieties. By taking the stable limits, symmetric Grothendieck functions G_λ are constructed, which we can use to form a basis for the ring of symmetric functions. By applying the ω involution, which sends the Schur function $s_\lambda \to s_{\lambda'}$ for the conjugate shape λ', we obtain the weak symmetric Grothendieck functions $J_\lambda := \omega G_\lambda$. Yeliussizov constructed a common generalization that he called the canonical Grothedieck functions.

The (resp. weak) (resp. canonical) symmetric Grothendieck functions are known to described as the sum over set-valued (resp. multiset-valued) (resp. hook-valued) tableaux. Furthermore, set-valued tableaux are known to have a type A_n crystal structure by modifying the usual semistandard tableaux crystal structure that comes from Kashiwara's theory of crystal bases on highest weight representations. In this talk, we give analogous results for multiset-valued and hook-valued tableaux, which shows that canonical Grothendieck functions are Schur-positive as an immediate corollary.

20.9. Real Groups, Hodge Theory, and the Langlands duality

Kari Vilonen (The University of Melbourne)

16:00 Wed 4 December 2019 – G62

Prof Kari Vilonen

I will explain how Hodge modules enter the representation theory of real groups. In particular, I will explain the conjectures of Schmid and myself and what is known about them.

21. Topology

21.1. Deformation of Curves and Topological Recursions

Wee chaimanowong (AMSI/University of Melbourne)

17:15 Wed 4 December 2019 – 137
Mr Wee chaimanowong

In 2017 Baraglia and Huang studied the Special Kahler geometry that arises from the moduli space of Higgs Bundles. They showed that the genus zero part of the topological recursion invariants of Eynard and Orantin compute the prepotential for the Special Kahler structure. In this talk we present an alternative approach to prove this result using Airy Structures of Kontsevich and Soibelman, and we propose a possible generalization.

21.2. Local topological recursion governs the enumeration of lattice points in $\overline{\mathcal{M}}_{g,n}$

Anupam Chaudhuri (Monash University)

13:55 Wed 4 December 2019 – 137
Mr Anupam Chaudhuri

The moduli space of curves has a cell decomposition in which each cell possesses the natural structure of a convex polytope. Norbury counted the lattice points in these convex polytopes and showed that the enumeration contains in-depth information about the moduli space itself. He furthermore proved that the enumeration is governed by topological recursion. Do and Norbury introduced the analogous enumeration of lattice points in the Deligne–Mumford compactification of the moduli space of curves. Furthermore, they ask whether the enumeration is governed by the topological recursion. In this talk, we will discuss this enumerative problem and show that it does indeed satisfy a local version of the topological recursion.

21.3. On the Goulden–Jackson–Vakil conjecture for double Hurwitz numbers

Norman Do (Monash University)

17:40 Wed 4 December 2019 – 137
Dr Norman Do

Hurwitz numbers enumerate branched covers of the sphere with prescribed ramification. Over the last two decades, they have received a great deal of attention in the literature, due to connections with algebraic geometry, representation theory and mathematical physics. The celebrated ELSV formula expresses single Hurwitz numbers as intersection numbers on moduli spaces of curves, from which it follows that they exhibit polynomial behaviour. Goulden, Jackson and Vakil showed that one-part double Hurwitz numbers are also polynomial, leading them to conjecture that they too arise as intersection numbers on some unidentified moduli spaces. In recent work with Danilo Lewanski, we give three partial resolutions to this conjecture, with our formulas leading to non-trivial relations between intersection numbers on moduli spaces of curves. In this talk, we will tell some of this story and present a precise statement of our results.

21.4. The Mapping Class Group Action on the Character Variety of the Once-Punctured Torus

Grace Garden (The University of Sydney)

16:00 Wed 4 December 2019 – 137
Ms Grace Garden

We follow the lead of Goldman in the study the action of the mapping class group on the SL(2, C)-character variety of the once-punctured torus. The action of the mapping class group in this context can be reduced to the action of polynomial automorphisms on the level sets of a specific polynomial, which corresponds to the trace of a peripheral element. One of the level sets is identified with Teichmüller space and with the hyperbolic plane. We describe two methods based on linear recurrence relations and hyperbolic geometry to extend the action of the mapping class group SL(2,Z) on the character variety to an action of the group SL(2,R). The two methods provide consistent results, which suggests the extension of the action to SL(2,R) is natural.

21.5. The topological period-index problem

Xing Gu (AMSI/University of Melbourne)

15:10 Fri 6 December 2019 – 137
Dr Xing Gu

The topological period-index problem (TPIP), an analogue to the long-standing period-index problem in algebraic geometry, concerns a given torsion class α in the 3rd integral cohomology group of a topological space X and various principal PU_n-bundles over X associated to α. Here PU_n is the projective unitary group of order n, i.e., the unitary group U_n modulo invertible scalars.

In this talk I will introduce recent work, joint with Crowley, Grant and Haesemeyer on the topological period-index problems over finite CW-complexes and manifolds.

21.6. Geometric Triangulations and Highly Twisted Knots

Sophie Ham (Monash University)

16:50 Tue 3 December 2019 – 137
Ms Sophie Ham

It remains an open question as to whether every cusped hyperbolic 3-manifold admits a geometric triangulation. Indeed, it is still unknown whether every knot complement admits a geometric triangulation. We prove that every highly twisted knot admits a geometric triangulation. Highly twisted links are obtained by Dehn filling a parent link, called a fully augmented link. In this talk, we review fully augmented links and their geometry, and show that they admit geometric triangulations with nice properties. We then describe a certain decomposition of a solid torus into ideal tetrahedra which will allow us to prove our main result. We end the talk with a discussion of some effective examples.

21.7. Complex Linking Numbers for Strata of Varieties

Martin Helmer (Australian National University)

13:55 Fri 6 December 2019 – 137

Dr Martin Helmer

Goresky and MacPherson's stratified Morse theory defines the complex link of a pair of strata for any Whitney stratified space; we call the Euler characteristic of the complex link the complex linking number. We consider a Whitney stratification of an algebraic variety V. Given two strata X and Y, with X contained in the closure of Y, we show that the complex linking number is equal to the Hilbert-Samuel multiplicity of the closure of X inside the closure of Y. This leads to a new expression for MacPherson's local Euler obstruction of V in terms of Hilbert-Samuel multiplicities and provides an effective method of the computation of local Euler obstructions and linking numbers. This is joint work with Vidit Nanda (Oxford).

21.8. Constructing geometric structures using twisted tetrahedra

Craig Hodgson (The University of Melbourne)

17:15 Tue 3 December 2019 – 137

Dr Craig Hodgson

The use of ideal triangulations to construct hyperbolic structures on 3-manifolds is a very powerful technique, introduced by Bill Thurston and implemented by Jeff Weeks in the computer programs SnapPea and SnapPy. However, this approach fails in some cases, including certain Dehn fillings on the figure eight knot complement. This talk will describe another approach to constructing hyperbolic, Euclidean and spherical structures using special fundamental domains built from "twisted tetrahedra", which are 3-cells with four right-angled hexagons as faces. This is based on joint work with James Dowty and Adam Wood.

21.9. Combinatorial isotopies

Boris Lishak (The University of Sydney)

16:00 Tue 3 December 2019 – 137

Dr Boris Lishak

We will show that piecewise linear isotopies of submanifolds can be represented by elementary combinatorial moves. Then we consider an application.

21.10. Homotopy Merge Trees in Topological Data Analysis

Kelly Maggs (The Australian National University)

16:25 Tue 3 December 2019 – 137

Kelly Maggs

Persistent homology is the cornerstone of TDA. A natural question is whether the same ethos of persistence can be applied in the homotopy setting. Existing theory has mainly focused on the case where a filtered topological space is path connected. By extending Morozov's definition of a topological merge tree, we introduce a new algebraic object - the homotopy merge tree - to deal with applications where filtering the homotopy groups of each filtered path component is of interest. We prove that our object satisfies three key properties:

- Stability: we can define an interleaving distance on our objects that satisfies the stability property. - Universality: we can recover the information about the persistent homology groups in all filtered path components at once. - Computability: we describe an algorithm to compute the homotopy merge tree in the first dimension, i.e. the fundamental group.

21.11. Geometry and physics of circle packings

Daniel Mathews (Monash University)

13:30 Wed 4 December 2019 – 137

Dr Daniel Mathews

I'll discuss some recent work in progress relating circle packings to various ideas in geometry and physics.

21.12. On the topological recursion for double Hurwitz numbers

Ellena Moskovsky (Monash University)

14:45 Wed 4 December 2019 – 137

Ellena Moskovsky

Hurwitz numbers enumerate branched covers of the Riemann sphere with specified branching. Single Hurwitz numbers have been shown to satisfy a polynomiality structure, and this was then used to prove that they are governed by the topological recursion of Chekhov, Eynard and Orantin. In this talk, we will discuss recent work with Borot, Do, Karev, and Lewański, in which we prove analogous results in the more general setting of double Hurwitz numbers. Finally, we will mention some consequences in algebraic geometry.

21.13. The Sullivan-conjecture in complex dimension 4

Csaba Nagy (The University of Melbourne)

15:35 Wed 4 December 2019 – 137
Mr Csaba Nagy

The Sullivan-conjecture claims that complex projective complete intersections are classified up to diffeomorphism by their total degree, Euler-characteristic and Pontryagin-classes. It follows from work of Kreck and Traving that the conjecture holds in complex dimension 4 if the total degree is divisible by 16. In this talk I will present the proof of the remaining cases. It is known that the conjecture holds up to connected sum with the exotic 8-sphere (this is a result of Fang and Klaus), so the essential part of our proof is understanding the effect of this operation on complete intersections. This is joint work with Diarmuid Crowley.

21.14. Polynomial relations among kappa classes on the moduli space of curves

Paul Norbury (The University of Melbourne)

16:00 Fri 6 December 2019 – 137
Prof Paul Norbury

We contruct an infinite collection of universal. i.e. independent of (g,n), polynomials in the Miller-Morita-Mumford kappa classes, defined over the moduli space of genus g stable curves with n labeled points. We conjecture vanishing of these polynomials in a range depending on g and n. This is joint work with Maxim Kazarian.

21.15. The triangulation complexity of fibred 3-manifolds

Jessica Purcell (Monash University)

15:10 Tue 3 December 2019 – 137
Prof Jessica Purcell

The triangulation complexity of a 3-manifold M is the minimal number of tetrahedra required to form a triangulation of M. It is a useful invariant, for example in computational topology, but surprisingly difficult to compute. We consider the case that M is a closed orientable hyperbolic 3-manifold that fibers over the circle. We show that the triangulation complexity of such a manifold is equal to the translation length of the monodromy action on the mapping class group of the fibre, up to a bounded factor depending only on the genus of the fibre. This is joint work with Marc Lackenby.

21.16. A descent-theoretic proof of a theorem of Serre

David Roberts (The University of Adelaide)

15:35 Fri 6 December 2019 – 137
Dr David Roberts

In response to a letter of Grothendieck, Serre proved that for a finite CW complex X (or a space homotopic to one) $\mathrm{Br}(X) = \mathrm{Br}'(X)$, where $\mathrm{Br}(X)$ is the Brauer group and $\mathrm{Br}'(X)$ is the torsion subgroup of $H^3(X,\mathbb{Z})$. The proof uses a Postnikov decomposition of a space with divisible homotopy groups. We will give a new proof that uses ideas from Gabber's thesis and descent theory for higher stacks, and moreover extend this to spaces with a finite cover $\{U_i\}$ such that $\mathrm{Br}(U_i) = \mathrm{Br}'(U_i)$ for each i.

21.17. Modelling homology operations in string topology

Marcy Robertson (The University of Melbourne)

13:30 Fri 6 December 2019 – 137
Dr Marcy Robertson

We describe a new algebraic model that captures gluing operations in a combinatorial model for the moduli space of genus g curves. This talk covers joint work with L. Bonnatto, S. Chettih, A. Linton, S. Raynor and N. Wahl.

21.18. Airy structures and topological recursion

Michael Swaddle (AMSI/University of Melbourne)

16:25 Wed 4 December 2019 – 137
Michael Swaddle

An Airy structure encodes a Lagrangian subvariety in a topological symplectic vector space W. Kontsevich and Soibelman introduce Airy structures, and show that they lead to topological recursion; which is an algorithm that can produce cohomology classes on the moduli space of curves (a cohomological field theory). In this talk, we first give details about this connection, and explain how to compute the invariants in topological recursion from the Airy structure.

21.19. Tautological classes with twisted coefficients

Mehdi Tavakol (The University of Melbourne)

14:20 Wed 4 December 2019 – 137
Dr Mehdi Tavakol

For a natural number $g > 1$ the moduli space M_g classifies smooth projective curves of genus g. In 1969 Deligne and Mumford proved that this space is irreducible and studied some of its fundamental properties. The geometry of moduli spaces of curves have been studied extensively since then by people from different perspectives. Many questions about the geometry of moduli of curves involve the so called tautological classes. They are the most natural classes on the space and appear in many questions about the geometry and topology of the moduli space. There are many interesting open questions and conjectures about the structure of the tautological ring. I will discuss a recent joint work with Dan Petersen and Qizheng Yin on tautological classes with twisted coefficients.

21.20. T-dualities of orbifolds

Guo Chuan Thiang (The University of Adelaide)

16:50 Wed 4 December 2019 – 137

Dr Guo Chuan Thiang

Topological T-duality manages the remarkable feat of exchanging inequivalent principal circle bundles, while conserving their twisted K-theories. Similarly, circle-bundles-with-involution may be exchanged while conserving twisted Real K-theories. Although these dualities have topological implications, they have intrinsic analytic/representation-theoretic ingredients. Building on this understanding, K. Gomi and I discovered a zoo of new dualities for flat orbifolds, which even exchanges the easy and hard parts of spectral sequence computations, providing a great service like the classic Fourier transform.

21.21. Braids and shuffle algebras

TriThang Tran (The University of Melbourne)

14:20 Fri 6 December 2019 – 137

Dr TriThang Tran

We will introduce the quantum shuffle algebra and its connection to the homology of braid groups. As a fun example, we will compute the homology o the configuration space of the plane. If time permits, we will discuss a result with Jordan Ellenberg and Craig Westerland on Malle's conjecture for function fields.

Index of Speakers