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Program Committee

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Local Organising Committee

Name – Conference Director
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Conference Program

Overview of the Academic Program

There are ?? talks, including ?? plenary lectures and ?? special sessions. The Education Afternoon on ?? comprises ?? talks accessible to a general mathematical audience.

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Plenary Lecturers

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Special Sessions

Education Afternoon

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Social Program

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  Event Name
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- Time
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  Event Location

Annual General Meeting of the Society

- Time
  Event Name
  Event Location

Conference Information Desk

The information desk for the conference is located ???. This desk will be staffed each day of the conference from ?? to ??.

Book and Software Display

Throughout the conference, various publishers will be displaying their wares in ??.

Plenary Lectures in [Name of plenary venue - defined in master.tex]

▷

▶ Nalini Joshi (The University of Sydney)
Riemann-Hilbert Problems

▷ Tue 8 December 2020

12:30 ▶ Kerrie Mengersen (Queensland University of Technology)
Back to the Future: ranking and selection

13:40 ▶ Robert Van Gorder (University of Otago)
Spatiotemporal pattern formation from non-autonomous reaction-diffusion systems

18:00 ▶ Lisa Beck (Universität Augsburg)
TBA

19:10 ▶ Reidun Twarock (University of York)
Mathematical Virology: Geometry as a key to the discovery of novel anti-viral solutions

▷ Wed 9 December 2020

10:00 ▶ Chris Rasmussen (San Diego State University)
Research on Learning and Teaching University Mathematics: Where we are and where we might go next

11:10 ▶ Alexander Molev (The University of Sydney)
Manin matrices, Casimir elements and Sugawara operators

18:00 ▶ Michael Eastwood (The University of Adelaide)
Some special geometries in dimension five

19:10 ▶ Gerhard Huisken (Tuebingen University)
Geometric evolution equations allowing change of topology

▷ Thu 10 December 2020

10:00 ▶ Rowena Ball (The Australian National University)
Clocks and cars and coded stars, and other complex things

11:40 ▶ Ilze Ziedins (The University of Auckland)
Modelling patient pathways to improve health care delivery

18:40 ▶ Henri Berestycki (EHESS - Ecole des Hautes Etudes en Sciences Sociales)
Reaction-diffusion systems and the Covid 19 epidemics

Session 1: Algebra

Organisers: James East, Michal Ferov

Contributed Talks

▷ Tue 8 December 2020

- 14:50 Heiko Dietrich (Monash University)
  Some comments on group isomorphism (p. 72)
- 15:20 Xueyu Pan (Monash University)
  Groups of small order type (p. 74)
- 15:50 Alex Bishop (University of Technology Sydney)
  Geodesic Growth in Virtually Abelian Groups (p. 72)
- 16:20 Murray Elder (University of Technology Sydney)
  What is a $\mathcal{C}$-Cayley position-faithful linear time computable group? (p. 72)

▷ Wed 9 December 2020

- 12:50 Stephan Tornier (The University of Newcastle)
  Think globally, act locally (p. 75)
- 13:20 Colin David Reid (The University of Newcastle)
  Abelian chief factors of locally compact groups (p. 74)
- 13:50 João Vitor Pinto e Silva (The University of Newcastle)
  Elementary Groups (p. 74)
- 14:20 Subhrajyoti Saha (Monash University)
  Orbit Isomorphic Skeleton Groups (p. 74)
- 14:50 Michal Ferov (The University of Newcastle)
  Conjugacy depth function for lamplighter groups is exponential (p. 73)

▷ Thu 10 December 2020

- 13:00 Tim Stokes (University of Waikato)
  Ordered semigroups and relation algebra. (p. 75)
- 13:30 Marcel Jackson (La Trobe University)
  Some curious semirings (p. 73)
- 14:00 James Mathew Koussas (La Trobe University)
  Probabilities of properties (p. 73)
- 14:30 Kevin Limanta (University of New South Wales)
  An Algebraic Interpretation of Super Catalan Numbers (p. 73)
- 15:00 James East (Western Sydney University)
  Transformation representations of semigroups (p. 72)

Session 2: Applied and Industrial Mathematics

Organisers: Mark Nelson, Harvinder Sidhu

Contributed Talks

▷ Tue 8 December 2020

14:50 Melanie Roberts (Australian Rivers Institute, Griffith University)
Potential benefit of wetlands in protecting the Great Barrier Reef from excess nutrient and sediment loads (p. 79)

15:20 Ashfaq Khan (RMIT University)
A DYNAMIC MECHANISTIC MODEL OF HYDROGEN-METHANOGEN PRODUCTION IN THE RUMEN WITH A RECYCLE (p. 78)

15:50 Salman Alsaeed (University of Wollongong)
A mathematical model for the activated sludge process (p. 75)

16:20 Kyle Jacob Stevens (The University of Newcastle)
New Functional Lennard-Jones Parameters for Heterogeneous Molecules (p. 80)

▷ Wed 9 December 2020

12:50 Matthew Holden (The University of Queensland)
Dynamics of illegal harvest (p. 77)

13:50 Simon Watt (UNSW Canberra)
Application of a delayed logistic equation to a reindeer population in a closed environment (p. 81)

14:20 Maria Kapsis (University of South Australia)
Optimal partitioning of photovoltaic modules on a curved solar collector (p. 78)

15:20 Timothy McLennan-Smith (University of New South Wales Canberra)
Emergent behaviour in an adversarial synchronisation and swarming model (p. 78)

15:50 Dylan Harries (CSIRO)
Dynamic Bayesian network models of climate teleconnections (p. 77)

16:20 Matthew Berry (University of Wollongong)
A Markov-Chain Monte-Carlo approach to estimation of parameters and uncertainty in Thermogravametric Analysis models (p. 76)

▷ Thu 10 December 2020

13:00 Bronwyn Hajek (University of South Australia)
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14:00 Philip Broadbridge (La Trobe University)
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14:30 Kirsten Louw (University of South Australia)
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15:30 Petrus van Heijster (Wageningen University and Research)
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16:00 Yvonne Stokes (The University of Adelaide)
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16:30 Luke Bennetts (The University of Adelaide)
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▷ Fri 11 December 2020

10:00 Natalie Thamwattana (The University of Newcastle)
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10:30 Tara Julia Hamilton (University of Technology Sydney)
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11:00 Lele (Joyce) Zhang (The University of Melbourne)
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15:00 Nikki Sonenberg (The Alan Turing Institute)
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15:30 Sevvandi Priyanvada Kandanaarachchi (RMIT University)
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16:00 Mark Nelson (University of Wollongong)
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Session 3: Category Theory, Algebraic Topology and K-Theory

Organisers: Marcy Robertson

Contributed Talks

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13:20 Bryce Clarke (Macquarie University)
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13:50 Giacomo Tendas (Macquarie University)
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14:50 Eli Hazel (Macquarie University)
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15:20 David Roberts (The University of Adelaide)
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15:50 Michelle Strumila (The University of Melbourne)
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▷ Thu 10 December 2020

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14:00 Paul Lessard (Macquarie University)
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14:30 Richard Garner (Macquarie University)
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10:00 Philip Hackney (University of Louisiana at Lafayette)
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11:00 Sophie Raynor (Macquarie University)
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12:00 Yuki Maehara (Macquarie University)
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12:30 Alexander Campbell (Macquarie University)
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Session 4: Combinatorics and Graph Theory

Organisers: Thomas Kalinowski

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15:50 Vsevolod Rakita (Technion, Israel Institute of Technology)
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16:20 Catherine Greenhill (University of New South Wales)
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13:00 Yudhistira Andersen Bunjamin (UNSW Sydney)
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13:30 James Bubear (RMIT University)
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14:00 Ian Roberts (Charles Darwin University)
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15:00 David Wood (Monash University)
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15:30 Nicholas Beaton (The University of Melbourne)
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16:00 Daniel Horsley (Monash University)
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Session 5: Computational Mathematics

Organisers: Bishnu Lamichhane, Quoc Thong Le Gia

Contributed Talks

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15:20 Benjamin Maldon (The University of Newcastle)
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15:50 Ryan Murphy (Queensland University of Technology)
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16:20 Alexander Gilbert (University of New South Wales)
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▷ Wed 9 December 2020

12:50 Ricardo Ruiz Baier (Monash University)
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13:50 Snigdha Mahanta (Institute of Advanced Study in Science and Technology)
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14:20 Aleksandar Badza (The University of Adelaide)
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14:50 Liam Yemm (Monash University)
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15:20 Farah El Rafei (UNSW Sydney)
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15:50 Gopikrishnan Chirappurathu Remesan (Monash University)
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16:20 Balaje Kalyanaraman (The University of Newcastle)
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16:50 Michael Meylan (The University of Newcastle)
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17:20 Arbaz Khan (Indian Institute of Technology Roorkee)
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13:00 Jerome Droniou (Monash University)
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13:30 Hailong Guo (The University of Melbourne)
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14:00 James Ashton Nichols (Australian National University)
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14:30 Kenneth Duru (The Australian National University)
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15:00 David Lee (Bureau of Meteorology)
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15:30 Vassili Kitsios (CSIRO)
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16:00 Thanh Tran (University of New South Wales)
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10:30 Quoc Thong Le Gia (University of New South Wales)
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Session 6: Complex analysis and geometry

Organisers: Vladimir Ejov, Adam Harris

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15:20 Finnur Larusson (The University of Adelaide)
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16:20 Nicholas Buchdahl (The University of Adelaide)
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▷ Wed 9 December 2020

13:20 Marcos Origlia (Monash University)
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13:50 Yuri Nikolayevsky (La Trobe University)
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14:20 Alessandro Ottazzi (University of New South Wales)
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13:00 Rod Gover (University of Auckland)
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14:00 Masoud Ganji (University of New England)
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Session 7: Dynamical Systems and Ergodic Theory

Organisers: Jason Atnip, Gary Froyland

Contributed Talks

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15:20 John Maclean (The University of Adelaide)
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15:50 Michael Charles Denes (UNSW Sydney)
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16:20 Courtney Rose Quinn (CSIRO)
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▷ Wed 9 December 2020

12:50 Jason Atnip (University of New South Wales)
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13:20 Fawwaz Batayneh (University of Queensland)
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13:50 Alexander Fish (The University of Sydney)
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15:20 Luchezar Stoyanov (The University of Western Australia)
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15:50 Cecilia Gonzalez-Tokman (The University of Queensland)
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16:20 Ian Lizarraga (The University of Sydney)
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16:50 William Clarke (The University of Sydney)
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13:00 Martin Wechselberger (The University of Sydney)
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13:30 Christopher P Rock (UNSW Sydney)
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14:00 Sanjeeva Balasuriya (The University of Adelaide)
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14:30 Georg Gottwald (The University of Sydney)
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Session 8: Functional Analysis, Operator Algebra, Non-commutative Geometry

Organisers: Lachlan MacDonald, David Robertson, Hemanth Saratchandran

Contributed Talks

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13:20 Alexander Mundey (University of Wollongong)
From Bass-Serre Theory to Cuntz-Pimsner algebras (p. 102)

13:50 Becky Armstrong (Victoria University of Wellington)
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14:20 Richard Garner (Macquarie University)
The étale category associated to an algebraic theory (p. 101)

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13:00 Ian Doust (University of New South Wales)
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13:30 Edward McDonald (UNSW Sydney)
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14:00 Arnaud Brothier (UNSW Sydney)
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14:30 Hendra Gunawan (Bandung Institute of Technology)
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Organisers: Qiang Guang, Haotian Wu, Zhou Zhang

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15:20 Valentina-Mira Wheeler (University of Wollongong)
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15:50 James McCoy (The University of Newcastle)
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16:20 Glen Wheeler (University of Wollongong)
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13:30 Ramiro Augusto Lafuente (The University of Queensland)
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14:00 Artem Pulemotov (The University of Queensland)
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15:00 Jonathan Julian Zhu (Australian National University)
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15:30 Medet Nursultanov (The University of Sydney)
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16:00 Jiakun Liu (University of Wollongong)
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Session 10: Harmonic Analysis

Organisers: Ji Li

Contributed Talks

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15:50 Pierre Portal (Australian National University)
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16:20 Peng Chen (sun yat sen university)
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▷ Wed 9 December 2020

12:50 Michael Cowling (University of New South Wales)
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13:50 Adam Sikora (Macquarie University)
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14:20 Sean Harris (The Australian National University)
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14:50 Jeffrey Hogan (The University of Newcastle)
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15:20 Hamed Baghal Ghaffari (The University of Newcastle)
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15:50 Neil Kristofer Dizon (The University of Newcastle)
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16:20 Yuguang Wang (Max Planck Institute; UNSW)
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13:00 José Manuel Conde Alonso (Universidad Autónoma de Madrid)
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13:30 Zihua Guo (Monash University)
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14:00 Zhijie Fan (sun yat sen university)
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14:30 Kangwei Li (Tianjin University)
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15:00 Jinghao Huang (University of New South Wales)
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Session 11: Inclusivity, diversity, and equity in mathematics

Organisers: Amie Albrecht, Andrew Francis

Contributed Talks

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16:20 Katherine Seaton (La Trobe University)
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▷ Wed 9 December 2020

12:50 Yudhistira Andersen Bunjamin (UNSW Sydney)
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13:20 Jessica Purcell (Monash University)
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Session 12: Mathematical Biology

Organisers: Timothy Schaerf

Contributed Talks

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15:20 Thomas Miller (University of South Australia)
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15:50 Albert Christian Soewongsono (University of Tasmania)
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16:20 Fillipe Harry Georgiou (The University of Newcastle)
Hungry, hungry hoppers: investigating the interaction of food distribution and gregarisation on the formation of locust hopper bands (p. 111)

▷ Wed 9 December 2020

12:50 Adrianne Jenner (Queensland University of Technology)
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13:20 Rajnesh Krishnan Mudaliar (University of New England)
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13:50 Joshua Stevenson (University of Tasmania)
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14:20 Jessica Crawshaw (The University of Melbourne)
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15:20 Jennifer Flegg (The University of Melbourne)
Mathematical model for the dynamics of vivax malaria infections (p. 110)

15:50 Andrew Francis (Western Sydney University)
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16:20 Zhao Mei Zheng (The University of Sydney)
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16:50 Anthia Le (The University of Queensland)
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13:00 Timothy Schaerf (University of New England)
Local interactions in the collective motion of Antarctic krill (p. 114)

13:30 Kamruzzaman Khan (University of New England)
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14:00 Viney Kumar (The University of Sydney)
How does the evolution of monogamy depend on human life history? (p. 113)

14:30 Alva Curtsdotter (University of New England)
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15:30 Mitchell Welch (University of New England)
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16:00 Douglas Brumley (The University of Melbourne)
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16:30 Edward Hancock (The University of Sydney)
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10:00 Eva Stadler (UNSW Sydney)
Modelling heterogeneous risk of malaria relapses in multiple recurrence data from a cohort study in Southeast Asia (p. 116)

10:30 ASHISH GOYAL (Fred Hutchinson Cancer Research Center)
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11:30 Sergiy Shelyag (Deakin University)
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12:00 Venta Terauds (University of Tasmania)
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Session 13: Mathematics Education

Organisers: Deborah King

Contributed Talks

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15:20 Deborah Jackson (La Trobe University)
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15:50 Terence Mills (La Trobe University)
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▷ Thu 10 December 2020

13:00 Mary Ruth Freislich (University of New South Wales)
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13:30 John Banks (The University of Melbourne)
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15:00 Anja Slim (Monash University)
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15:30 Poh Hillock (The University of Queensland)
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16:00 Joanne Hall (Royal Melbourne Institute of Technology)
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16:30 Dmitry Demskoi (Charles Sturt University)
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Organisers: Johanna Knapp, Jock McOrist, Gabriele Tartaglino-Mazzucchelli

Contributed Talks

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13:20 Yury Stepanyants (University of Southern Queensland)
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13:50 Pieter Hubert van der Kamp (La Trobe University)
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14:20 Thomas Quella (The University of Melbourne)
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15:20 Ian Marquette (University of Queensland)
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16:20 Travis Scrimshaw (The University of Queensland)
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16:50 Jules Lamers (The University of Melbourne)
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Session 15: Number Theory and Algebraic Geometry

Organisers: Liangyi Zhao

Contributed Talks

▷ Tue 8 December 2020

14:50 Peng Gao (Beihang University)
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16:20 Igor Shparlinski (UNSW Sydney)
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▷ Wed 9 December 2020

12:50 Lenny Fukshansky (Claremont McKenna College)
On sparse geometry of numbers (p. 124)

13:20 Satyanand Singh (NYCCT of CUNY)
Computing the fourth term of of Nathanson's lambda $\lambda_{2,3}(h)$ sequence and limit points of $\lambda_{2,n}(h)$ sequences. (p. 127)

13:50 Forrest James Francis (Australian Defence Force Academy)
Smoothed Pólya–Vinogradov Inequalities (p. 124)

14:50 Philip Bos (La Trobe University)
The generalised Hausdorff measure of sets of Dirichlet non-improvable numbers (p. 123)

15:20 Ethan Simpson Lee (UNSW Canberra)
Comparing Results to study the Distribution of Prime Ideals in a Number Field (p. 126)

15:50 Sean Lynch (UNSW Sydney)
The Solomon zeta function (p. 127)

16:50 Ralf Steiner (NWF (LI))
To the median of the even leg of a pPT and to the prime numbers of the form $p \equiv 1($ mod 12). (p. 127)

17:20 Hayder Hashim (Institute of Mathematics, University of Debrecen)
Solutions of generalizations of Markoff equation from linear recurrences (p. 125)

▷ Thu 10 December 2020

13:00 Benjamin Hutz (Saint Louis University)
Rational Preperiodic Points for Endomorphisms of Projective Space with Automorphisms (p. 126)

13:30 Michaela Cully-Hugill (University of New South Wales Canberra)
Updating the Bertrand-type estimate for primes in intervals (p. 124)

14:00 Matteo Bordignon (University of New South Wales Canberra)
Approximated solution of a differential-difference equation arising in number theory and applications to the linear sieve (p. 123)

15:00 Florian Breuer (The University of Newcastle)
Multiplicative orders of Gauss periods and real quadratic fields (p. 124)

15:30 Randell Heyman (University of New South Wales)
Sums of arithmetic functions involving the gcd and lcm (p. 126)

16:00 Richard P Brent (Australian National University)
Estimation of sums over zeros of the Riemann zeta-function (p. 123)

16:30 Timothy Trudgian (UNSW Canberra)
Sign changes in the prime number theorem: past and present! (p. 128)

Session 16: Optimisation

Organisers: Minh N. Dao, Guoyin Li, Matthew Tam

Contributed Talks

▷ Tue 8 December 2020

14:50 Regina S. Burachik (University of South Australia)
Generalized Bregman envelopes and proximity operators (p. 128)

15:50 Thi Hoa Bui (Curtin University)
Necessary Conditions for Non-Intersection of Collections of Sets (p. 128)

16:20 Shoham Sabach (Technion, Israel Institute of Technology)
Faster Lagrangian-Based Methods in Convex Optimization (p. 133)

▷ Wed 9 December 2020

12:50 Ting Kei Pong (Hong Kong Polytechnic University)
Convergence rate analysis of a sequential convex programming method with line search for a class of constrained difference-of-convex optimization problems (p. 132)

13:20 Lindon Roberts (Australian National University)
Block Methods for Scalable Derivative-Free Optimisation (p. 133)

13:50 Mitchell Harris (The University of Queensland)
Logic-Based Benders Decompostion for Resource Allocation Problems (p. 129)

14:20 Lucas Gamertsfelder (Macquarie University)
LP Based Bounds for Cesaro and Abel Limits of the Optimal Values in Non-ergodic Stochastic Systems (p. 129)

15:20 Chayne Planiden (University of Wollongong)
New Gradient and Hessian Approximation Methods for Derivative-free Optimisation (p. 132)

15:50 Vera Roshchina (UNSW Sydney)
Amenable, nice and projectively exposed cones: new relations and open problems (p. 133)

16:20 Xuemei Liu (University of South Australia)
A Primal-Dual Method with Applications to Optimal Control (p. 131)

16:50 Hong-Kun Xu (Hangzhou Dianzi University)
Projected Subgradient Methods in Infinite Dimensional Spaces (p. 134)

17:20 Russell Luke (University of Goettingen)
Random Function Iterations for Stochastic Fixed Point Problems (p. 131)

▷ Thu 10 December 2020

13:00 David Kirszenblat (Defence Science and Technology Group)
Mission Path Planning for Optimal ISAR Vessel Classification (p. 130)

13:30 Vinesha Peiris (Swinburne University of Technology)
The extension of linear inequality method for generalised rational Chebyshev approximation. (p. 132)

14:00 Bethany Caldwell (University of South Australia)
Multivariate Extensions of a Generalized Newton Method (p. 129)

14:30 Xiaoming Yuan (The University of Hong Kong)

An ADMM-Newton-CNN Numerical Approach to a TV Model for Identifying Discontinuous Diffusion Coefficients in Elliptic Equations: Convex Case with Gradient Observations (p. 134)

▷ Fri 11 December 2020

10:00 Christopher Schneider (University of Applied Sciences Jena)
Regularization Parameter Tracking in Machine Learning (p. 133)

10:30 Ruben Campoy (Universitat de Valencia)
Weak convergence of the adaptive Douglas–Rachford algorithm (p. 129)

11:00 Jingwei Liang (Queen Mary University of London)
A Chasing Douglas–Rachford Splittng Method for Feasibility Problem (p. 130)

11:30 Nam Ho-Nguyen (The University of Sydney)
Distributionally Robust Chance-Constrained Programs under Wasserstein Ambiguity (p. 130)

12:00 Yalcin Kaya (University of South Australia)
Some Applications of Multiobjective Optimal Control (p. 130)

14:00 Heinz Bauschke (University of British Columbia, Okanagan)
Displacement mappings and fixed point sets of compositions of projections (p. 128)

15:00 Björn Rüffer (The University of Newcastle)
Make Alternating Projections great again (p. 132)

15:30 Janosch Rieger (Monash University)
A learning-enhanced projection method for solving convex feasibility problems (p. 132)

16:00 Scott Boivin Lindstrom (Hong Kong Polytechnic University)
Computable centering methods for spiraling algorithms and their duals, with motivations from the theory of Lyapunov functions (p. 131)

Session 17: Partial Differential Equations

Organisers: Ting-Ying Chang, Yihong Du

Contributed Talks

▷ Tue 8 December 2020

14:50 Neil Trudinger (Australian National University)
Hessian estimates for Monge-Ampère type equations and applications (p. 138)

15:50 Jiakun Liu (University of Wollongong)
Free boundary in optimal partial transport (p. 136)

16:20 Qiang Guang (Australian National University)
The Minkowski problem in the sphere (p. 136)

▷ Wed 9 December 2020

12:50 Serena Dipierro (The University of Western Australia)
Nonlocal logistic equations with Neumann conditions (p. 135)

13:20 Luca Lombardini (The University of Western Australia)
Boundary stickiness of nonlocal minimal surfaces (p. 136)

13:50 Wenhui Shi (Monash University)
Γ-limit for a phase transition model in magnetization (p. 138)

14:20 Zhewen Feng (The University of Queensland)
A new representation for the Landau-de Gennes energy of nematic liquid crystals (p. 135)

15:20 Enrico Valdinoci (The University of Western Australia)
The Bernstein technique for integrodifferential equations (p. 138)

15:50 Wenjie Ni (University of New England)
Semi-wave, traveling wave and spreading speed for monostable cooperative systems with nonlocal diffusion and free boundaries (p. 137)

16:20 Ting-Ying Chang (University of New England)
Reaction-diffusion model with nonlocal diffusion and free boundaries (p. 135)

16:50 Rong Wang (University of New England)
Long-time dynamics of a Diffusive Epidemic Model with Free Boundaries (p. 138)

▷ Thu 10 December 2020

13:00 Xu-Jia Wang (Australian National University)
Prescribed Gauss curvature problems (p. 138)

14:00 Daniel Hauer (The University of Sydney)
More insights into the Trudinger-Moser inequality with monomial weight (p. 136)

14:30 Maria Farcaseanu (The University of Sydney)
Sharp existence and classification results for nonlinear elliptic equations in $\mathbb{R}^N \setminus \{0\}$ with Hardy potential (p. 135)

15:30 Florica Corina Cirstea (The University of Sydney)
Anisotropic elliptic equations with gradient-dependent lower order terms and L^1 data (p. 135)

16:00 Giorgio Poggesi (The University of Western Australia)
Symmetry and stability for some problems in PDEs (p. 137)

Session 18: Probability Theory and Stochastic Processes

Organisers: Andrea Collevecchio, Jie Yen Fan, Kais Hamza

Contributed Talks

▷ Tue 8 December 2020

14:50 Beniamin Goldys (The University of Sydney)
Heat equation with boundary noise (p. 140)

15:50 Fima Klebaner (Monash University)
New universality in stochastic systems (p. 141)

16:20 Chunxi Jiao (The University of Sydney)
Semidefinite relaxations for exit-time stochastic control (p. 141)

▷ Wed 9 December 2020

12:50 ZHIHAO QIAO (The University of Queensland)
Hidden Equations of Threshold Risk (p. 144)

13:20 Kostya Borovkov (The University of Melbourne)
Ruin probabilities in the presence of risky investments and random switching (p. 139)

13:50 Hugh Entwistle (Macquarie University)
The Asymptotics of Optimal Stopping Times (p. 140)

14:50 Peter Taylor (The University of Melbourne)
Safe Blues (p. 144)

15:20 Illia Donhauzer (La Trobe University)
Strong Law of Large Numbers for Functionals of Random Fields (p. 139)

15:50 Nan Zou (Macquarie University)
When does massive-data bootstrap work? (p. 145)

16:50 Ravindi Nanayakkara (La Trobe University)
Spherical Monofractal and Multifractal Random Fields with Cosmological Applications (p. 142)

17:20 Laurence Field (Australian National University)
TBA (p. 140)

▷ Thu 10 December 2020

13:00 Chunlei Jin (The University of Sydney)
Weighted nonlinear regression with nonstationary time series (p. 141)

13:30 Malgorzata Marzena O'Reilly (University of Tasmania)
Matrix-Analytic Methods for the analysis of Stochastic Fluid-Fluid Models (p. 143)

14:00 Oscar Peralta (The University of Adelaide)
Rate of strong convergence to solutions of regime-switching stochastic differential equations (p. 143)

15:00 Philip Keith Pollett (University of Queensland)
High-density limits for infinite occupancy processes (p. 143)

15:30 Andriy Olenko (La Trobe University)
On the running maxima of φ-subgaussian random fields (p. 143)

16:00 Sarat Babu Moka (The University of Queensland)
Rare-Event Simulation for Random Geometric Graphs (p. 142)

▷ Fri 11 December 2020

10:00 Ruth J Williams (UC San Diego)
Asymptotic Behavior of a Critical Fluid Model for Bandwidth Sharing with General File Size Distributions (p. 144)

10:30 Andrea Collevecchio (Monash University)
Topics in Random Games (p. 139)

11:00 Han Liang Gan (The University of Waikato)
Stationary distribution approximations for two-island Wright-Fisher models (p. 140)

12:00 Ross Maller (Australian National University)
A remarkable invariance property for the Dickman subordi (p. 142)

12:30 Jeremy Sumner (University of Tasmania)
Uniformization-stable Markov models (p. 144)

14:00 Tim Brown (Monash University)
Revisting stochastic calculus for point processes (p. 139)

14:30 Jesse Goodman (University of Auckland)
How accurate is the saddlepoint approximation for MLEs? (p. 140)

15:00 Libo Li (University of New South Wales)
Optimal stopping problems up to a random time horizon (p. 141)

Session 19: Representation Theory

Organisers: Kevin Coulembier, Oded Yacobi

Contributed Talks

▷ Tue 8 December 2020

14:50 Joseph Baine (The University of Sydney)
p-Kazhdan-Lusztig polynomials for (co)minuscule flag varieties (p. 145)

15:20 Sinead Wilson (The Australian National University)
Curve complexes in topology and triangulated categories (p. 148)

15:50 Simon Riche (Université Clermont Auvergne)
Character formulas for representations of reductive algebraic groups in positive characteristic (p. 147)

▷ Wed 9 December 2020

12:50 Edmund Xian Chen Heng (Australian National University)
Categorifying Burau representations and categorical dynamics (p. 146)

13:20 Kane Townsend (The University of Sydney)
Minimal reflection subgroups containing Sylow subgroups (p. 148)

13:50 Giulian Wiggins (The University of Sydney)
Heisenberg categorification in positive characteristic (p. 148)

15:20 Mengfan Lyu (The University of Sydney)
Cellular structures of the Temperley-Lieb algebra (p. 147)

15:50 Nick Bridger (University of Queensland)
Topology and geometry of representation varieties via point counting (p. 145)

16:20 Arun Ram (The University of Melbourne)
Extremal weight modules, global Weyl modules and local Weyl modules (p. 147)

16:50 Inna Entova-Aizenbud (Ben Gurion University)
Jacobson-Morozov Lemma for Lie superalgebras using semisimplification (p. 146)

▷ Thu 10 December 2020

13:30 Dougal Davis (University of Edinburgh)
Subregular elliptic slices and deformations of singularities (p. 146)

14:00 Yang Zhang (The University of Sydney)
Noncrossing algebras and Milnor fibres of reflection arrangements (p. 148)

14:30 Vinoth Nandakumar (The University of Sydney)
Categorification via modular representations of sl_n, and Lusztig's conjectures (p. 147)

15:30 Anna Puskas (The University of Queensland)
Double affine Hecke algebras and the Bruhat order (p. 147)

16:00 Jie Du (University of New South Wales)
The regular representations of quantum linear and queer supergroups (p. 146)

16:30 Anthony Henderson (The University of Sydney)
Braid groups of normalizers of reflection subgroups (p. 146)

Session 20: Topology

Organisers: Bea Bleile, Imre Bokor, Jessica Purcell

Contributed Talks

▷ Tue 8 December 2020

14:50 Marcy Robertson (The University of Melbourne)
A homotopy associative model for the 2D cobordism category (p. 152)

15:20 Carol Badre (The University of Sydney)
All closed orientable 3-manifolds are central in trisections of 5-manifolds (p. 149)

15:50 Thiago de Paiva Souza (Monash University)
Morton's Conjecture About Lorenz Knots (p. 150)

16:20 Tamara Hogan (The University of Melbourne)
Symmetries of trivalent tangles: Approaching the link between Drinfeld associators and Kashiwara-Vergne solutions (p. 151)

▷ Wed 9 December 2020

12:50 Jonathan Spreer (The University of Sydney)
The complexity of manifolds (p. 154)

13:20 Ellena Moskovsky (Monash University)
Fully simple maps and topological recursion (p. 152)

13:50 John Etienne Stewart (Monash University)
Constructing geometrically convergent knot complements (p. 154)

14:20 Anand Rajendra Deopurkar (Australian National University)
A Thurston compactification for ... categories (p. 150)

15:20 Daniel Mathews (Monash University)
Ptolemy vs Thurston in hyperbolic geometry and topology (p. 151)

15:50 Emily Thompson (Monash University)
A-polynomials of knots related by Dehn filling (p. 155)

16:20 Muwafaq Mahdi Salih (University of Debrecen)
Minimality Properties of the Family $\mathcal{T}^{p}_{\mathcal{R}}$ in Relator Spaces (p. 152)

16:50 Stephan Tillmann (The University of Sydney)
The space of properly-convex structures (p. 155)

▷ Thu 10 December 2020

13:00 Joan Licata (Australian National University)
Gluing Contact Manifolds via Foliated Open Books (p. 151)

13:30 Sophie Ham (Monash University)
Geometric triangulations and highly twisted links (p. 151)

14:00 José Ayala Hoffmann (The University of Melbourne)
Immersed flat ribbon knots (p. 149)

14:30 Katharine Turner (Australian National University)
Wasserstein stability for persistence diagrams (p. 155)

15:30 Paul Norbury (The University of Melbourne)
Deformations of curves in symplectic surfaces (p. 152)

16:00 Mehdi Tavakol (The University of Melbourne)
An action of the Polishchuk differential operator via punctured surfaces (p. 154)

16:30 Zsuzsanna Dancso (The University of Sydney)
Over-then-under Tangles (p. 149)

▷ Fri 11 December 2020

10:00 Norman Do (Monash University)
The structure and geometry of double Hurwitz numbers (p. 150)

10:30 Urs Fuchs (Monash University)
Basic properties of maps tamed by a differential form (p. 150)

11:00 Diarmuid Crowley (The University of Melbourne)
The derivate map for diffeomorphisms of discs (p. 149)

Conference Timetable Summary

<table>
<tr><th></th><th>Sunday</th><th>Monday</th><th colspan="2">Tuesday</th><th>Wednesday</th><th>Thursday</th></tr>
<tr><td>8:00</td><td rowspan="14"></td><td></td><td colspan="2"></td><td></td><td></td></tr>
<tr><td>8:30</td><td rowspan="2">Registrations</td><td colspan="2" rowspan="2">Plenary talk
Johnstone</td><td rowspan="2">Plenary talk
Venkatesh</td><td rowspan="2">Plenary talk
Hyeon</td></tr>
<tr><td>9:00</td></tr>
<tr><td>9:30</td><td rowspan="2">Opening Ceremony</td><td colspan="2" rowspan="2">Plenary talk
Boland</td><td rowspan="2">Plenary talk
Hegland</td><td rowspan="2">Plenary talk
Jonsson</td></tr>
<tr><td>10:00</td></tr>
<tr><td>10:30</td><td>Morning Tea</td><td colspan="2">Morning Tea</td><td>Morning Tea</td><td>Morning Tea</td></tr>
<tr><td>11:00</td><td rowspan="2">Plenary talk
Henderson</td><td colspan="2" rowspan="2">Plenary talk
Noumi</td><td rowspan="2">Plenary talk
Champagnat</td><td rowspan="2">Plenary talk
Briant</td></tr>
<tr><td>11:30</td></tr>
<tr><td>12:00</td><td rowspan="3">Lunch</td><td colspan="2" rowspan="3">Lunch</td><td rowspan="3">Lunch</td><td rowspan="3">Lunch</td></tr>
<tr><td>12:30</td></tr>
<tr><td>13:00</td></tr>
<tr><td>13:30</td><td rowspan="2">Plenary talk
Boyd</td><td rowspan="4">Education Afternoon</td><td rowspan="4">Special Sessions</td><td rowspan="2">Plenary talk
Ringel</td><td rowspan="4">Special Sessions</td></tr>
<tr><td>14:00</td></tr>
<tr><td>14:30</td><td rowspan="2">Special Sessions</td><td rowspan="2">Special Sessions</td></tr>
<tr><td>15:00</td><td rowspan="6">Registrations</td></tr>
<tr><td>15:30</td><td>Coffee Break</td><td colspan="2">Coffee Break</td><td>Coffee Break</td><td>Coffee Break</td></tr>
<tr><td>16:00</td><td rowspan="4">Special Sessions</td><td rowspan="4">Education Afternoon</td><td rowspan="4">Special Sessions</td><td rowspan="2">AustMS annual general meeting</td><td rowspan="3">Special Sessions</td></tr>
<tr><td>16:30</td></tr>
<tr><td>17:00</td><td rowspan="2">Special Sessions</td></tr>
<tr><td>17:30</td><td rowspan="5"></td></tr>
<tr><td>18:00</td><td rowspan="4"></td><td rowspan="2"></td><td colspan="2" rowspan="2"></td><td></td></tr>
<tr><td>18:30</td><td rowspan="3">Conference Dinner</td></tr>
<tr><td>19:00</td><td rowspan="2">Public Lecture
Venkatesh</td><td colspan="2" rowspan="2">Public Lecture
Gentry</td></tr>
<tr><td>19:30</td></tr>
<tr><td>20:00</td><td colspan="6"></td></tr>
</table>

Mon 7 December 2020

- Summary timetable

When	What	Where
09:30–16:30	Early Career Workshop	s
19:00–20:00	Wimsig Forum	s
20:00–21:00	Meet and greet on gather.town	s

Tue 8 December 2020

Summary timetable

When	What	Where
10:00–12:00	**Plenary:** (p. ??)	Join Zoom room
12:00–12:30	Break	s
12:30–13:30	**Plenary:** Mengersen (p. 70)	Join Zoom room
13:40–14:40	**Plenary:** Van Gorder (p. 71)	Join Zoom room
14:50–15:50	5 special session talks	Various rooms (see below)
14:50–15:20	11 special session talks	Various rooms (see below)
15:20–16:20	2 special session talks	Various rooms (see below)
15:20–15:50	9 special session talks	Various rooms (see below)
15:50–16:50	Keynote talk	s
15:50–16:20	12 special session talks	Various rooms (see below)
16:20–16:50	15 special session talks	Various rooms (see below)
17:00–18:00	Welcome reception on gather.town	s
18:00–19:00	**Plenary:** Beck (p. 69)	Join Zoom room
19:10–20:10	**Plenary:** Twarock (p. 71)	Join Zoom room

Non-plenary Sessions

2. Algebra

Join Zoom room

14:50 Heiko Dietrich (Monash University)
Some comments on group isomorphism (p. 72)

15:20 Xueyu Pan (Monash University)
Groups of small order type (p. 74)

15:50 Alex Bishop (University of Technology Sydney)
Geodesic Growth in Virtually Abelian Groups (p. 72)

16:20 Murray Elder (University of Technology Sydney)
What is a $\mathcal{C}$-Cayley position-faithful linear time computable group? (p. 72)

3. Applied and Industrial Mathematics

Null room

14:50 Melanie Roberts (Australian Rivers Institute, Griffith University)
Potential benefit of wetlands in protecting the Great Barrier Reef from excess nutrient and sediment loads (p. 79)

15:20 Ashfaq Khan (RMIT University)
A DYNAMIC MECHANISTIC MODEL OF HYDROGEN-METHANOGEN PRODUCTION IN THE RUMEN WITH A RECYCLE (p. 78)

15:50 Salman Alsaeed (University of Wollongong)
A mathematical model for the activated sludge process (p. 75)

16:20 Kyle Jacob Stevens (The University of Newcastle)
New Functional Lennard-Jones Parameters for Heterogeneous Molecules (p. 80)

5. Combinatorics and Graph Theory

Join Zoom room

14:50 Suil O (SUNY Korea)
Matchings in graphs from spectral radius (p. 86)

15:20 Ajani De Vas Gunasekara (Monash University)
An Evans-style result for block designs (p. 86)

15:50 Vsevolod Rakita (Technion, Israel Institute of Technology)
Harary Polynomials (p. 87)

16:20 Catherine Greenhill (University of New South Wales)
Mixing time of the switch Markov chain and stable degree sequences (p. 86)

6. Computational Mathematics

Join Zoom room

14:50 Alexander Gilbert (University of New South Wales)
Approximating probabilities using preintegrated quasi-Monte Carlo methods (p. 90)

15:20 Benjamin Maldon (The University of Newcastle)
A Fractional Diffusion Model for Dye-Sensitized Solar Cells (p. 92)

15:50 Ryan Murphy (Queensland University of Technology)
Mechanical cell competition in heterogeneous epithelial tissues (p. 93)

16:20 Abirami Srikumar (UNSW Sydney)
Applications of rank-1 lattice rules to exact function reconstruction in the non-periodic setting (p. 93)

7. Complex analysis and geometry

Join Zoom room

14:50 Elliot Herrington (The University of Adelaide)
Highly symmetric homogeneous Kobayashi-hyperbolic manifolds (p. 95)

15:20 Finnur Larusson (The University of Adelaide)
Legendrian holomorphic curves in complex projective 3-space and superminimal surfaces in the 4-sphere (p. 95)

16:20 Nicholas Buchdahl (The University of Adelaide)
Polystability and the Hitchin-Kobayashi correspondence (p. 94)

8. Dynamical Systems and Ergodic Theory

Join Zoom room

14:50 Carlo Laing (Massey University)
Dynamics of heterogeneous networks of Winfree oscillators (p. 98)

15:20 John Maclean (The University of Adelaide)
Searching for an ergodic PIG: unresolved issues in simulating extremely multiscale systems (p. 99)

15:50 Michael Charles Denes (UNSW Sydney)
Identifying Coherent Ocean Features From Swarms of Virtual Drifters (p. 97)

16:20 Courtney Rose Quinn (CSIRO)
Dynamical analysis of a reduced model for the North Atlantic Oscillation (p. 99)

11. Harmonic Analysis

Join Zoom room

14:50 Andrew Hassell (Australian National University)
Wave equations with rough coefficients on L^p spaces (p. 106)

15:50 Pierre Portal (Australian National University)
Fixed time Lp estimates for wave equations with structured Lipschitz coefficients (p. 107)

16:20 Peng Chen (sun yat sen university)

Almost everywhere convergence of Bochner-Riesz means for the Hermite operators (p. 104)

12. Inclusivity, diversity, and equity in mathematics

Null room

14:50 Birgit Loch (La Trobe University)
Update on the peer-mentoring program towards female academic promotion and introduction of the WATTLE program (p. 108)

15:20 Aidan Sims (University of Wollongong)
Panel discussion: Allyship in Mathematics and Statistics Departments (p. 109)

16:20 Katherine Seaton (La Trobe University)
Touching and hearing mathematics (p. 109)

13. Mathematical Biology

Join Zoom room

14:50 Mary Myerscough (The University of Sydney)
Structured Population Models for Macrophages in Atherosclerotic Plaques (p. 114)

15:20 Thomas Miller (University of South Australia)
Mammalian Oocyte Fertilisation Waves (p. 113)

15:50 Albert Christian Soewongsono (University of Tasmania)
The Shape of Phylogenies Under Phase–Type Distributed Times to Speciation and Extinction (p. 115)

16:20 Fillipe Harry Georgiou (The University of Newcastle)
Hungry, hungry hoppers: investigating the interaction of food distribution and gregarisation on the formation of locust hopper bands (p. 111)

14. Mathematics Education

Join Zoom room

14:50 Chris Tisdell (University of New South Wales)
Community in the Classroom: Practical strategies to foster students' sense of belonging in mathematics (p. 120)

15:20 Deborah Jackson (La Trobe University)
Comparing mathematics and statistics support BC (before COVID) and DC (during COVID) (p. 119)

15:50 Terence Mills (La Trobe University)
Learning progressions for mathematics (p. 119)

16:20 Attila Egri-Nagy (Akita International University)
Igo Math - Smuggling more Mathematics into the Liberal Arts curriculum with the help of the ancient game of Go (p. 118)

16. Number Theory and Algebraic Geometry

Join Zoom room

14:50 Peng Gao (Beihang University)
The fourth moment of quadratic Hecke L-functions in $Q(i)$ (p. 124)

16:20 Igor Shparlinski (UNSW Sydney)
Correlation between Salié sums and second moments of some half integral weight L-series (p. 127)

17. Optimisation

Null room

14:50 Regina S. Burachik (University of South Australia)
Generalized Bregman envelopes and proximity operators (p. 128)

15:50 Thi Hoa Bui (Curtin University)
Necessary Conditions for Non-Intersection of Collections of Sets (p. 128)

16:20 Shoham Sabach (Technion, Israel Institute of Technology)
Faster Lagrangian-Based Methods in Convex Optimization (p. 133)

18. Partial Differential Equations

Join Zoom room

14:50 Neil Trudinger (Australian National University)
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15:50 Jiakun Liu (University of Wollongong)
Free boundary in optimal partial transport (p. 136)

16:20 Qiang Guang (Australian National University)
The Minkowski problem in the sphere (p. 136)

19. Probability Theory and Stochastic Processes

Join Zoom room

14:50 Beniamin Goldys (The University of Sydney)
Heat equation with boundary noise (p. 140)

15:50 Fima Klebaner (Monash University)
New universality in stochastic systems (p. 141)

16:20 Chunxi Jiao (The University of Sydney)
Semidefinite relaxations for exit-time stochastic control (p. 141)

20. Representation Theory

Null room

14:50 Joseph Baine (The University of Sydney)
p-Kazhdan-Lusztig polynomials for (co)minuscule flag varieties (p. 145)

15:20 Sinead Wilson (The Australian National University)
Curve complexes in topology and triangulated categories (p. 148)

15:50 Simon Riche (Université Clermont Auvergne)
Character formulas for representations of reductive algebraic groups in positive characteristic (p. 147)

21. Topology

Join Zoom room

14:50 Marcy Robertson (The University of Melbourne)
A homotopy associative model for the 2D cobordism category (p. 152)

15:20 Carol Badre (The University of Sydney)
All closed orientable 3-manifolds are central in trisections of 5-manifolds (p. 149)

15:50 Thiago de Paiva Souza (Monash University)
Morton's Conjecture About Lorenz Knots (p. 150)

16:20 Tamara Hogan (The University of Melbourne)
Symmetries of trivalent tangles: Approaching the link between Drinfeld associators and Kashiwara-Vergne solutions (p. 151)

Wed 9 December 2020

Summary timetable

When	What	Where
10:00–11:00	**Plenary:** Rasmussen (p. 71)	Join Zoom room
11:10–12:10	**Plenary:** Molev (p. 70)	Join Zoom room
12:10–12:40	Break	s
12:50–13:50	3 special session talks	Various rooms (see below)
12:50–13:20	13 special session talks	Various rooms (see below)
13:20–14:20	Keynote	Join Zoom room
13:20–13:50	14 special session talks	Various rooms (see below)
13:50–14:20	16 special session talks	Various rooms (see below)
14:00–17:00	Education Afternoon	Join Zoom room
14:20–14:50	12 special session talks	Various rooms (see below)
14:50–15:20	6 special session talks	Various rooms (see below)
15:20–16:20	Keynote	s
15:20–15:50	13 special session talks	Various rooms (see below)
15:50–16:20	13 special session talks	Various rooms (see below)
16:20–16:50	11 special session talks	Various rooms (see below)
16:50–17:50	Keynote	s
16:50–17:20	9 special session talks	Various rooms (see below)
17:20–17:50	4 special session talks	Various rooms (see below)
18:00–19:00	**Plenary:** Eastwood (p. 70)	Join Zoom room
19:10–20:10	**Plenary:** Huisken (p. 70)	Join Zoom room

Non-plenary Sessions

2. Algebra

Join Zoom room

12:50 Stephan Tornier (The University of Newcastle)
Think globally, act locally (p. 75)

13:20 Colin David Reid (The University of Newcastle)
Abelian chief factors of locally compact groups (p. 74)

13:50 João Vitor Pinto e Silva (The University of Newcastle)
Elementary Groups (p. 74)

14:20 Subhrajyoti Saha (Monash University)
Orbit Isomorphic Skeleton Groups (p. 74)

14:50 Michal Ferov (The University of Newcastle)
Conjugacy depth function for lamplighter groups is exponential (p. 73)

3. Applied and Industrial Mathematics

Null room

- 12:50 Matthew Holden (The University of Queensland)
  Dynamics of illegal harvest (p. 77)
- 13:50 Simon Watt (UNSW Canberra)
  Application of a delayed logistic equation to a reindeer population in a closed environment (p. 81)
- 14:20 Maria Kapsis (University of South Australia)
  Optimal partitioning of photovoltaic modules on a curved solar collector (p. 78)
- 15:20 Timothy McLennan-Smith (University of New South Wales Canberra)
  Emergent behaviour in an adversarial synchronisation and swarming model (p. 78)
- 15:50 Dylan Harries (CSIRO)
  Dynamic Bayesian network models of climate teleconnections (p. 77)
- 16:20 Matthew Berry (University of Wollongong)
  A Markov-Chain Monte-Carlo approach to estimation of parameters and uncertainty in Thermogravametric Analysis models (p. 76)

4. Category Theory, Algebraic Topology and K-Theory

- 12:50 Stephen Lack (Macquarie University)
  Accessible infinity-cosmoi (p. 83)
- 13:20 Bryce Clarke (Macquarie University)
  Generalising fibrations via multi-valued functions (p. 82)
- 13:50 Giacomo Tendas (Macquarie University)
  Dualities for accessible categories (p. 85)
- 14:50 Eli Hazel (Macquarie University)
  Stone-type dualities from categorical first principles (p. 83)
- 15:20 David Roberts (The University of Adelaide)
  How to be concrete when you don't have a choice (p. 84)
- 15:50 Michelle Strumila (The University of Melbourne)
  Quasi modular operads (p. 84)

6. Computational Mathematics

Join Zoom room

- 12:50 Ricardo Ruiz Baier (Monash University)
  Numerical methods for stress-assisted diffusion models for biomechanics (p. 93)
- 13:50 Snigdha Mahanta (Institute of Advanced Study in Science and Technology)
  On M/G/1 feedback queueing system with repeated service under N-policy and a random setup time (p. 92)
- 14:20 Aleksandar Badza (The University of Adelaide)
  The Impact of Grid Velocity Resolution on the Detection of Lagrangian Coherent Structures (p. 88)
- 14:50 Liam Yemm (Monash University)
  Hybrid High-Order methods with small faces (p. 94)
- 15:20 Farah El Rafei (UNSW Sydney)
  Stochastic Landau-Lifshitz equation on real line (p. 89)
- 15:50 Gopikrishnan Chirappurathu Remesan (Monash University)
  Numerical solution of a two dimensional tumour growth model with moving boundary (p. 88)
- 16:20 Balaje Kalyanaraman (The University of Newcastle)
  Vibrations of Ice Shelves (p. 90)
- 16:50 Michael Meylan (The University of Newcastle)
  Wave Interaction with Floating Elastic Plates (p. 92)
- 17:20 Arbaz Khan (Indian Institute of Technology Roorkee)

Divergence conforming discontinuous Galerkin method for Stokes eigenvalue Problems (p. 91)

7. Complex analysis and geometry

Join Zoom room

13:20 Marcos Origlia (Monash University)
Conformal Killing Yano 2-forms on Lie groups (p. 96)

13:50 Yuri Nikolayevsky (La Trobe University)
Einstein hypersurfaces of rank-one symmetric spaces (p. 95)

14:20 Alessandro Ottazzi (University of New South Wales)
Conformal and CR mappings on stratified groups (p. 96)

8. Dynamical Systems and Ergodic Theory

Join Zoom room

12:50 Jason Atnip (University of New South Wales)
Random Open Interval Maps (p. 96)

13:20 Fawwaz Batayneh (University of Queensland)
On the existence and number of random invariant measures for higher dimensional random dynamical systems (p. 97)

13:50 Alexander Fish (The University of Sydney)
Quantitative twisted recurrence (p. 98)

15:20 Luchezar Stoyanov (The University of Western Australia)
Pesin sets with exponentially small tails and exponential mixing for Anosov flows (p. 100)

15:50 Cecilia Gonzalez-Tokman (The University of Queensland)
Random dynamical systems and their Lyapunov Oseledets spectrum (p. 98)

16:20 Ian Lizarraga (The University of Sydney)
Contact and delay: loss of normal hyperbolicity in general slow-fast dynamical systems (p. 98)

16:50 William Clarke (The University of Sydney)
Rigorous justification of the Whitham modulation theory for equations of NLS type (p. 97)

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

Join Zoom room

12:50 Aidan Sims (University of Wollongong)
Reconstruction of graphs from C-algebraic data* (p. 102)

13:20 Alexander Mundey (University of Wollongong)
From Bass-Serre Theory to Cuntz-Pimsner algebras (p. 102)

13:50 Becky Armstrong (Victoria University of Wellington)
Twisted Steinberg algebras (p. 100)

14:20 Richard Garner (Macquarie University)
The étale category associated to an algebraic theory (p. 101)

10. Geometric Analysis

Join Zoom room

13:20 Lu Wang (California Institute of Technology)
Nonuniqueness question in mean curvature flow (p. 103)

14:20 Paul Bryan (Macquarie University)
Constant rank theorems for prescribed curvature equations (p. 102)

15:20 Valentina-Mira Wheeler (University of Wollongong)
Curvature flow model for dorsal closure (p. 104)

15:50 James McCoy (The University of Newcastle)

Higher order curvature flow of plane curves with generalised Neumann boundary conditions (p. 103)

16:20 Glen Wheeler (University of Wollongong)
The entropy flow for planar curves (p. 104)

11. Harmonic Analysis

Join Zoom room

12:50 Michael Cowling (University of New South Wales)
Flag Hardy spaces (p. 105)

13:50 Adam Sikora (Macquarie University)
Hardy spaces and harmonic weights (p. 107)

14:20 Sean Harris (The Australian National University)
The Heisenberg group and pseudodifferential calculus in new settings (p. 106)

14:50 Jeffrey Hogan (The University of Newcastle)
Clifford translations, wavelets and splines (p. 106)

15:20 Hamed Baghal Ghaffari (The University of Newcastle)
Properties of higher-dimensional Clifford Prolate Spheroidal Wave Functions (p. 104)

15:50 Neil Kristofer Dizon (The University of Newcastle)
A feasibility approach to quaternion-valued wavelet construction (p. 105)

16:20 Yuguang Wang (Max Planck Institute; UNSW)
Tight Framelets and Fast Framelet Filter Bank Transforms on Manifolds (p. 107)

12. Inclusivity, diversity, and equity in mathematics

Null room

12:50 Yudhistira Andersen Bunjamin (UNSW Sydney)
Equity considerations in the design of online mathematics outreach (p. 108)

13:20 Jessica Purcell (Monash University)
How WIMSIG can help (p. 108)

13. Mathematical Biology

Join Zoom room

12:50 Adrianne Jenner (Queensland University of Technology)
Quantitative modelling distinguishes severity in the immune response to SARS-CoV-2 (p. 112)

13:20 Rajnesh Krishnan Mudaliar (University of New England)
Systematic analysis of a hybrid zonal model (p. 113)

13:50 Joshua Stevenson (University of Tasmania)
Circular Genome Rearrangements and the Hyperoctahedral Group (p. 116)

14:20 Jessica Crawshaw (The University of Melbourne)
To collapse or not to collapse: how do mechanical forces drive vascular regression? (p. 110)

15:20 Jennifer Flegg (The University of Melbourne)
Mathematical model for the dynamics of vivax malaria infections (p. 110)

15:50 Andrew Francis (Western Sydney University)
The case for normal phylogenetic networks (p. 111)

16:20 Zhao Mei Zheng (The University of Sydney)
Bridging Agent-Based Modelling with Equation-Based Modelling of COVID-19 pandemic in New South Wales. (p. 117)

16:50 Anthia Le (The University of Queensland)
The Evolution of Menopause (p. 113)

15. Mathematical Physics, Statistical Mechanics and Integrable systems

Null room

12:50 Zachary Fehily (The University of Melbourne)
Modularity in Logarithmic Conformal Field Theories (p. 121)

13:20 Yury Stepanyants (University of Southern Queensland)
Emergence of envelop solitary waves from the localised pulses within the Ostrovsky equation (p. 122)

13:50 Pieter Hubert van der Kamp (La Trobe University)
Boundary consistency, open reductions, and intersection maps (p. 123)

14:20 Thomas Quella (The University of Melbourne)
Symmetry-protected topological phases beyond groups: The q-deformed bilinear-biquadratic spin chain (p. 122)

15:20 Ian Marquette (University of Queensland)
Painlevé transcendents in quantum mechanics and related algebraic structures (p. 121)

16:20 Travis Scrimshaw (The University of Queensland)
Coloring K-Theoretic Schubert Calculus With Lattice Models (p. 122)

16:50 Jules Lamers (The University of Melbourne)
Recent advances for integrable long-range spin chains (p. 121)

16. Number Theory and Algebraic Geometry

Join Zoom room

12:50 Lenny Fukshansky (Claremont McKenna College)
On sparse geometry of numbers (p. 124)

13:20 Satyanand Singh (NYCCT of CUNY)
Computing the fourth term of of Nathanson's lambda $\lambda_{2,3}(h)$ sequence and limit points of $\lambda_{2,n}(h)$ sequences. (p. 127)

13:50 Forrest James Francis (Australian Defence Force Academy)
Smoothed Pólya–Vinogradov Inequalities (p. 124)

14:50 Philip Bos (La Trobe University)
The generalised Hausdorff measure of sets of Dirichlet non-improvable numbers (p. 123)

15:20 Ethan Simpson Lee (UNSW Canberra)
Comparing Results to study the Distribution of Prime Ideals in a Number Field (p. 126)

15:50 Sean Lynch (UNSW Sydney)
The Solomon zeta function (p. 127)

16:50 Ralf Steiner (NWF (LI))
To the median of the even leg of a pPT and to the prime numbers of the form $p \equiv 1 (\bmod 12)$. (p. 127)

17:20 Hayder Hashim (Institute of Mathematics, University of Debrecen)
Solutions of generalizations of Markoff equation from linear recurrences (p. 125)

17. Optimisation

Null room

12:50 Ting Kei Pong (Hong Kong Polytechnic University)
Convergence rate analysis of a sequential convex programming method with line search for a class of constrained difference-of-convex optimization problems (p. 132)

13:20 Lindon Roberts (Australian National University)
Block Methods for Scalable Derivative-Free Optimisation (p. 133)

13:50 Mitchell Harris (The University of Queensland)
Logic-Based Benders Decompostion for Resource Allocation Problems (p. 129)

14:20 Lucas Gamertsfelder (Macquarie University)

LP Based Bounds for Cesaro and Abel Limits of the Optimal Values in Non-ergodic Stochastic Systems (p. 129)

15:20 Chayne Planiden (University of Wollongong)
New Gradient and Hessian Approximation Methods for Derivative-free Optimisation (p. 132)

15:50 Vera Roshchina (UNSW Sydney)
Amenable, nice and projectively exposed cones: new relations and open problems (p. 133)

16:20 Xuemei Liu (University of South Australia)
A Primal-Dual Method with Applications to Optimal Control (p. 131)

16:50 Hong-Kun Xu (Hangzhou Dianzi University)
Projected Subgradient Methods in Infinite Dimensional Spaces (p. 134)

17:20 Russell Luke (University of Goettingen)
Random Function Iterations for Stochastic Fixed Point Problems (p. 131)

18. Partial Differential Equations

Join Zoom room

12:50 Serena Dipierro (The University of Western Australia)
Nonlocal logistic equations with Neumann conditions (p. 135)

13:20 Luca Lombardini (The University of Western Australia)
Boundary stickiness of nonlocal minimal surfaces (p. 136)

13:50 Wenhui Shi (Monash University)
Γ*-limit for a phase transition model in magnetization* (p. 138)

14:20 Zhewen Feng (The University of Queensland)
A new representation for the Landau-de Gennes energy of nematic liquid crystals (p. 135)

15:20 Enrico Valdinoci (The University of Western Australia)
The Bernstein technique for integrodifferential equations (p. 138)

15:50 Wenjie Ni (University of New England)
Semi-wave, traveling wave and spreading speed for monostable cooperative systems with nonlocal diffusion and free boundaries (p. 137)

16:20 Ting-Ying Chang (University of New England)
Reaction-diffusion model with nonlocal diffusion and free boundaries (p. 135)

16:50 Rong Wang (University of New England)
Long-time dynamics of a Diffusive Epidemic Model with Free Boundaries (p. 138)

19. Probability Theory and Stochastic Processes

Join Zoom room

12:50 ZHIHAO QIAO (The University of Queensland)
Hidden Equations of Threshold Risk (p. 144)

13:20 Kostya Borovkov (The University of Melbourne)
Ruin probabilities in the presence of risky investments and random switching (p. 139)

13:50 Hugh Entwistle (Macquarie University)
The Asymptotics of Optimal Stopping Times (p. 140)

14:50 Peter Taylor (The University of Melbourne)
Safe Blues (p. 144)

15:20 Illia Donhauzer (La Trobe University)
Strong Law of Large Numbers for Functionals of Random Fields (p. 139)

15:50 Nan Zou (Macquarie University)
When does massive-data bootstrap work? (p. 145)

16:50 Ravindi Nanayakkara (La Trobe University)
Spherical Monofractal and Multifractal Random Fields with Cosmological Applications (p. 142)

17:20 Laurence Field (Australian National University)

TBA (p. 140)

20. Representation Theory

Null room

12:50 Edmund Xian Chen Heng (Australian National University)
Categorifying Burau representations and categorical dynamics (p. 146)

13:20 Kane Townsend (The University of Sydney)
Minimal reflection subgroups containing Sylow subgroups (p. 148)

13:50 Giulian Wiggins (The University of Sydney)
Heisenberg categorification in positive characteristic (p. 148)

15:20 Mengfan Lyu (The University of Sydney)
Cellular structures of the Temperley-Lieb algebra (p. 147)

15:50 Nick Bridger (University of Queensland)
Topology and geometry of representation varieties via point counting (p. 145)

16:20 Arun Ram (The University of Melbourne)
Extremal weight modules, global Weyl modules and local Weyl modules (p. 147)

16:50 Inna Entova-Aizenbud (Ben Gurion University)
Jacobson-Morozov Lemma for Lie superalgebras using semisimplification (p. 146)

21. Topology

Join Zoom room

12:50 Jonathan Spreer (The University of Sydney)
The complexity of manifolds (p. 154)

13:20 Ellena Moskovsky (Monash University)
Fully simple maps and topological recursion (p. 152)

13:50 John Etienne Stewart (Monash University)
Constructing geometrically convergent knot complements (p. 154)

14:20 Anand Rajendra Deopurkar (Australian National University)
A Thurston compactification for ... categories (p. 150)

15:20 Daniel Mathews (Monash University)
Ptolemy vs Thurston in hyperbolic geometry and topology (p. 151)

15:50 Emily Thompson (Monash University)
A-polynomials of knots related by Dehn filling (p. 155)

16:20 Muwafaq Mahdi Salih (University of Debrecen)
Minimality Properties of the Family $\mathcal{T}^{p}_{\mathcal{R}}$ *in Relator Spaces* (p. 152)

16:50 Stephan Tillmann (The University of Sydney)
The space of properly-convex structures (p. 155)

Thu 10 December 2020

Summary timetable

When	What	Where
10:00–11:30	**Plenary:** Ball (p. 69)	Join Zoom room
11:40–12:40	**Plenary:** Ziedins (p. 72)	Join Zoom room
12:40–13:00	Break	s
13:00–14:00	3 special session talks	Various rooms (see below)
13:00–13:30	14 special session talks	Various rooms (see below)
13:30–14:30	Keynote	Join Zoom room
13:30–14:00	14 special session talks	Various rooms (see below)
14:00–14:30	17 special session talks	Various rooms (see below)
14:30–15:00	12 special session talks	Various rooms (see below)
15:00–15:30	8 special session talks	Various rooms (see below)
15:30–16:00	12 special session talks	Various rooms (see below)
16:00–16:30	11 special session talks	Various rooms (see below)
16:30–17:00	8 special session talks	Various rooms (see below)
17:00–18:00	AGM	Join Zoom room
18:40–19:40	**Plenary:** Berestycki (p. 69)	Join Zoom room
19:40–21:10	Closing and B.H. Neumann Prize	s

Non-plenary Sessions

2. Algebra

Join Zoom room

13:00 Tim Stokes (University of Waikato)
Ordered semigroups and relation algebra. (p. 75)

13:30 Marcel Jackson (La Trobe University)
Some curious semirings (p. 73)

14:00 James Mathew Koussas (La Trobe University)
Probabilities of properties (p. 73)

14:30 Kevin Limanta (University of New South Wales)
An Algebraic Interpretation of Super Catalan Numbers (p. 73)

15:00 James East (Western Sydney University)
Transformation representations of semigroups (p. 72)

3. Applied and Industrial Mathematics

 Null room

 13:00 Bronwyn Hajek (University of South Australia)
 Analytic solution of various reaction-diffusion models (p. 76)

 14:00 Philip Broadbridge (La Trobe University)
 Exact and Numerical solutions of nonlinear Fisher-KPP reaction-diffusion equations: Design of marine protection areas. (p. 76)

 14:30 Kirsten Louw (University of South Australia)
 van der Waals interactions between ferric ions and MOF pores (p. 78)

 15:30 Petrus van Heijster (Wageningen University and Research)
 Travelling wave solutions in a reaction-diffusion model with nonlinear forward-backward-forward diffusion (p. 80)

 16:00 Yvonne Stokes (The University of Adelaide)
 A two-dimensional asymptotic model for capillary collapse (p. 80)

 16:30 Luke Bennetts (The University of Adelaide)
 Complex resonant ice shelf vibrations (p. 75)

4. Category Theory, Algebraic Topology and K-Theory

 13:00 Olivia Borghi (The University of Melbourne)
 An Operadic "Unitarization Trick" (p. 81)

 13:30 Adrian Miranda (Macquarie University)
 Decalage comonad and their restrictions (p. 84)

 14:00 Paul Lessard (Macquarie University)
 Towards a 'Practical Type Theory for Symmetric Monoidal Bicategories' (p. 83)

 14:30 Richard Garner (Macquarie University)
 A universal characterisation of self-homeomomorphisms of Cantor space (p. 82)

5. Combinatorics and Graph Theory

 Join Zoom room

 13:00 Yudhistira Andersen Bunjamin (UNSW Sydney)
 Group divisible designs of block size 4 with group sizes 3 and 6 (p. 85)

 13:30 James Bubear (RMIT University)
 Geometry of Mutually Unbiased Bases in Dimension 6 (p. 85)

 14:00 Ian Roberts (Charles Darwin University)
 Using marginal analysis to analyse the discrete Kruskal-Katona function and antichains, and some related functions defined on ordered collections of sets. (p. 87)

 15:00 David Wood (Monash University)
 Stack-number is not bounded by queue-number (p. 87)

 15:30 Nicholas Beaton (The University of Melbourne)
 Walks obeying two-step rules on the square lattice (p. 85)

 16:00 Daniel Horsley (Monash University)
 Fraisse limits of Steiner triple systems (p. 86)

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

6. Computational Mathematics

 Join Zoom room

 13:00 Jerome Droniou (Monash University)
 Numerical analysis of two-phase flows models with mechanical deformation in fracture porous media (p. 89)

 13:30 Hailong Guo (The University of Melbourne)
 Hessian recovery based finite element methods for the Cahn-Hilliard equation (p. 90)

 14:00 James Ashton Nichols (Australian National University)
 Nonlinear reduced modelling and state estimation of parametric PDEs (p. 93)

14:30 Kenneth Duru (The Australian National University)
On the stability of the PML for propagating waves in SBP and DG methods (p. 89)

15:00 David Lee (Bureau of Meteorology)
Energetically consistent upwinding for Hamiltonian systems in geophysics using mixed finite elements (p. 92)

15:30 Vassili Kitsios (CSIRO)
Ensemble transform Kalman filter parameter estimation for reduced biases in a global coupled climate model (p. 91)

16:00 Thanh Tran (University of New South Wales)
Remarks on Sobolev norms of fractional orders (p. 94)

16:30 Matthew Colbrook (University of Cambridge)
Diagonalising Infinite-Dimensional Operators: Computing spectral measures of self-adjoint operators (p. 88)

7. Complex analysis and geometry

Join Zoom room

13:00 Rod Gover (University of Auckland)
A conformally invariant Yang-Mills energy and equation on 6-manifolds (p. 95)

14:00 Masoud Ganji (University of New England)
Sasaki geometry and a construction of a quasi-Einstein shearfree spacetimes (p. 94)

8. Dynamical Systems and Ergodic Theory

Join Zoom room

13:00 Martin Wechselberger (The University of Sydney)
Geometric singular perturbation theory beyond the standard form (p. 100)

13:30 Christopher P Rock (UNSW Sydney)
Higher Cheeger and dynamic Cheeger constant bounds in terms of Laplace-Beltrami and dynamic Laplacian eigenvalues (p. 99)

14:00 Sanjeeva Balasuriya (The University of Adelaide)
On uncertain conclusions of Lagrangian coherence (p. 96)

14:30 Georg Gottwald (The University of Sydney)
Simulation of non-Lipschitz stochastic differential equations driven by α-stable noise: a method based on deterministic homogenisation (p. 98)

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

Join Zoom room

13:00 Ian Doust (University of New South Wales)
Gelfand-Kolmogorov families (p. 101)

13:30 Edward McDonald (UNSW Sydney)
Lipschitz estimates in quasi-Banach Schatten ideals (p. 101)

14:00 Arnaud Brothier (UNSW Sydney)
Jones actions of Thompson groups and others (p. 101)

14:30 Hendra Gunawan (Bandung Institute of Technology)
On the g-angle between two subspaces of a normed space (p. 101)

10. Geometric Analysis

Join Zoom room

13:00 Julie Clutterbuck (Monash University)
Spectral gap in hyperbolic space (p. 102)

13:30 Ramiro Augusto Lafuente (The University of Queensland)
On the signature of the Ricci curvature on nilmanifolds (p. 102)

14:00 Artem Pulemotov (The University of Queensland)
Maxima of the scalar curvature functional on compact homogeneous spaces (p. 103)

15:00 Jonathan Julian Zhu (Australian National University)
Explicit Lojasiewicz inequalities for mean curvature flow shrinkers (p. 104)

15:30 Medet Nursultanov (The University of Sydney)
On the Mean First Arrival Time of Brownian Particles on Riemannian Manifolds (p. 103)

16:00 Jiakun Liu (University of Wollongong)
Non-compact L_p-Minkowski problems (p. 103)

11. Harmonic Analysis

Join Zoom room

13:00 José Manuel Conde Alonso (Universidad Autónoma de Madrid)
A Calderón-Zygmund decomposition for von Neumann algebra valued functions (p. 105)

13:30 Zihua Guo (Monash University)
Bourgain space associated to Schrodinger operator (p. 106)

14:00 Zhijie Fan (sun yat sen university)
L^p estimates and weighted estimates of fractional maximal rough singular integrals on homogeneous groups (p. 105)

14:30 Kangwei Li (Tianjin University)
Multilinear weighted estimates in product spaces (p. 107)

15:00 Jinghao Huang (University of New South Wales)
Operator θ-Hölder functions with respect to L_p-norms, $0 < p \leq \infty$. (p. 106)

15:30 ()
(p. **??**)

13. Mathematical Biology

Join Zoom room

13:00 Timothy Schaerf (University of New England)
Local interactions in the collective motion of Antarctic krill (p. 114)

13:30 Kamruzzaman Khan (University of New England)
Effects of environmental heterogeneity on species spreading with free boundary reaction diffusion models (p. 112)

14:00 Viney Kumar (The University of Sydney)
How does the evolution of monogamy depend on human life history? (p. 113)

14:30 Alva Curtsdotter (University of New England)
A Dynamic Energy Budget model for dung beetles (p. 110)

15:30 Mitchell Welch (University of New England)
Analysis of Collective States and Their Transitions in Football (p. 116)

16:00 Douglas Brumley (The University of Melbourne)
Cellular navigation in dynamic, noisy environments (p. 109)

16:30 Edward Hancock (The University of Sydney)
The interplay of feedback and buffering in cellular homeostasis (p. 111)

14. Mathematics Education

Join Zoom room

13:00 Mary Ruth Freislich (University of New South Wales)
The benefits of online formative assessment for tertiary mathematics students (p. 118)

13:30 John Banks (The University of Melbourne)
Forum: Online delivery and assessment under Covid-19 conditions (p. 117)

15:00 Anja Slim (Monash University)
Engagement in a large first-year engineering maths unit during lockdown (p. 120)

15:30 Poh Hillock (The University of Queensland)
Online delivery of first year maths: challenges and opportunities (p. 119)

16:00 Joanne Hall (Royal Melbourne Institute of Technology)
The Non-Technical Skills Employers Want (p. 118)

16:30 Dmitry Demskoi (Charles Sturt University)
MathAssess - a system for creating and delivering formative mathematical assessments (p. 117)

16. Number Theory and Algebraic Geometry

Join Zoom room

13:00 Benjamin Hutz (Saint Louis University)
Rational Preperiodic Points for Endomorphisms of Projective Space with Automorphisms (p. 126)

13:30 Michaela Cully-Hugill (University of New South Wales Canberra)
Updating the Bertrand-type estimate for primes in intervals (p. 124)

14:00 Matteo Bordignon (University of New South Wales Canberra)
Approximated solution of a differential-difference equation arising in number theory and applications to the linear sieve (p. 123)

15:00 Florian Breuer (The University of Newcastle)
Multiplicative orders of Gauss periods and real quadratic fields (p. 124)

15:30 Randell Heyman (University of New South Wales)
Sums of arithmetic functions involving the gcd and lcm (p. 126)

16:00 Richard P Brent (Australian National University)
Estimation of sums over zeros of the Riemann zeta-function (p. 123)

16:30 Timothy Trudgian (UNSW Canberra)
Sign changes in the prime number theorem: past and present! (p. 128)

17. Optimisation

Null room

13:00 David Kirszenblat (Defence Science and Technology Group)
Mission Path Planning for Optimal ISAR Vessel Classification (p. 130)

13:30 Vinesha Peiris (Swinburne University of Technology)
The extension of linear inequality method for generalised rational Chebyshev approximation. (p. 132)

14:00 Bethany Caldwell (University of South Australia)
Multivariate Extensions of a Generalized Newton Method (p. 129)

14:30 Xiaoming Yuan (The University of Hong Kong)
An ADMM-Newton-CNN Numerical Approach to a TV Model for Identifying Discontinuous Diffusion Coefficients in Elliptic Equations: Convex Case with Gradient Observations (p. 134)

18. Partial Differential Equations

Join Zoom room

13:00 Xu-Jia Wang (Australian National University)
Prescribed Gauss curvature problems (p. 138)

14:00 Daniel Hauer (The University of Sydney)
More insights into the Trudinger-Moser inequality with monomial weight (p. 136)

14:30 Maria Farcaseanu (The University of Sydney)
Sharp existence and classification results for nonlinear elliptic equations in $\mathbb{R}^N \setminus \{0\}$ *with Hardy potential* (p. 135)

15:30 Florica Corina Cirstea (The University of Sydney)
Anisotropic elliptic equations with gradient-dependent lower order terms and L^1 *data* (p. 135)

16:00 Giorgio Poggesi (The University of Western Australia)
Symmetry and stability for some problems in PDEs (p. 137)

19. Probability Theory and Stochastic Processes

Join Zoom room

13:00 Chunlei Jin (The University of Sydney)
Weighted nonlinear regression with nonstationary time series (p. 141)

13:30 Malgorzata Marzena O'Reilly (University of Tasmania)
Matrix-Analytic Methods for the analysis of Stochastic Fluid-Fluid Models (p. 143)

14:00 Oscar Peralta (The University of Adelaide)
Rate of strong convergence to solutions of regime-switching stochastic differential equations (p. 143)

15:00 Philip Keith Pollett (University of Queensland)
High-density limits for infinite occupancy processes (p. 143)

15:30 Andriy Olenko (La Trobe University)
On the running maxima of φ-subgaussian random fields (p. 143)

16:00 Sarat Babu Moka (The University of Queensland)
Rare-Event Simulation for Random Geometric Graphs (p. 142)

20. Representation Theory

Null room

13:30 Dougal Davis (University of Edinburgh)
Subregular elliptic slices and deformations of singularities (p. 146)

14:00 Yang Zhang (The University of Sydney)
Noncrossing algebras and Milnor fibres of reflection arrangements (p. 148)

14:30 Vinoth Nandakumar (The University of Sydney)
Categorification via modular representations of sl_n, and Lusztig's conjectures (p. 147)

15:30 Anna Puskas (The University of Queensland)
Double affine Hecke algebras and the Bruhat order (p. 147)

16:00 Jie Du (University of New South Wales)
The regular representations of quantum linear and queer supergroups (p. 146)

16:30 Anthony Henderson (The University of Sydney)
Braid groups of normalizers of reflection subgroups (p. 146)

21. Topology

Join Zoom room

13:00 Joan Licata (Australian National University)
Gluing Contact Manifolds via Foliated Open Books (p. 151)

13:30 Sophie Ham (Monash University)
Geometric triangulations and highly twisted links (p. 151)

14:00 José Ayala Hoffmann (The University of Melbourne)
Immersed flat ribbon knots (p. 149)

14:30 Katharine Turner (Australian National University)
Wasserstein stability for persistence diagrams (p. 155)

15:30 Paul Norbury (The University of Melbourne)
Deformations of curves in symplectic surfaces (p. 152)

16:00 Mehdi Tavakol (The University of Melbourne)
An action of the Polishchuk differential operator via punctured surfaces (p. 154)

16:30 Zsuzsanna Dancso (The University of Sydney)
Over-then-under Tangles (p. 149)

Fri 11 December 2020

■ Summary timetable

When	What	Where
10:00–11:00	Keynote	s
10:00–10:30	6 special session talks	Various rooms (see below)
10:30–11:00	6 special session talks	Various rooms (see below)
11:00–11:30	6 special session talks	Various rooms (see below)
11:30–12:00	2 special session talks	Various rooms (see below)
12:00–12:30	4 special session talks	Various rooms (see below)
12:30–13:00	2 special session talks	Various rooms (see below)
14:00–15:00	Keynote talk	s
14:00–14:30	Keynote talk	Join Zoom room
14:30–15:00	Keynote talk	Join Zoom room
15:00–15:30	3 special session talks	Various rooms (see below)
15:30–16:00	2 special session talks	Various rooms (see below)
16:00–16:30	2 special session talks	Various rooms (see below)

■ Non-plenary Sessions

3. Applied and Industrial Mathematics

Null room

10:00 Natalie Thamwattana (The University of Newcastle)
Conformation of Graphene Wrinkles Formed on a Shrinking Solid Metal Substrate (p. 80)

10:30 Tara Julia Hamilton (University of Technology Sydney)
Neuromorphic Modelling of Disease Models (p. 77)

11:00 Lele (Joyce) Zhang (The University of Melbourne)
Study of a location routing problem for joint delivery networks (p. 81)

15:00 Nikki Sonenberg (The Alan Turing Institute)
Performance analysis of work stealing in large scale multithreaded computing (p. 79)

15:30 Sevvandi Priyanvada Kandanaarachchi (RMIT University)
Linking Item Response Theory to algorithm evaluation (p. 77)

16:00 Mark Nelson (University of Wollongong)
Writing a report for the mayor: encouraging mathematics students to see the value in written communication (p. 79)

4. Category Theory, Algebraic Topology and K-Theory

10:00 Philip Hackney (University of Louisiana at Lafayette)
Higher properads (p. 83)

11:00 Sophie Raynor (Macquarie University)
An operadic perspective on compact closed categories (p. 84)

12:00 Yuki Maehara (Macquarie University)
The Gray tensor product for 2-quasi-categories (p. 84)

12:30 Alexander Campbell (Macquarie University)
The model category of algebraically cofibrant 2-categories (p. 82)

6. Computational Mathematics

Join Zoom room

10:00 Bishnu Lamichhane (The University of Newcastle)
A mixed finite element method for fourth and sixth-order elliptic problems (p. 91)

10:30 Quoc Thong Le Gia (University of New South Wales)
Existence of martingale solution to stochastic Navier-Stokes equations on a spherical shell (p. 91)

13. Mathematical Biology

Join Zoom room

10:00 Eva Stadler (UNSW Sydney)
Modelling heterogeneous risk of malaria relapses in multiple recurrence data from a cohort study in Southeast Asia (p. 116)

10:30 ASHISH GOYAL (Fred Hutchinson Cancer Research Center)
The impact of SARS-CoV-2 viral dynamics on population level spread, super-spreader events, and optimization of masking and antiviral therapy (p. 111)

11:00 Maia Nikolova Angelova (Deakin University)
Data Driven Model for Detecting Acute and Chronic Insomnia (p. 109)

11:30 Sergiy Shelyag (Deakin University)
Global Stability and Periodicity in a Glucose-Insulin Regulation Model with a Single Delay (p. 115)

12:00 Venta Terauds (University of Tasmania)
Irreducible semigroup-based Markov models (p. 116)

17. Optimisation

Null room

10:00 Christopher Schneider (University of Applied Sciences Jena)
Regularization Parameter Tracking in Machine Learning (p. 133)

10:30 Ruben Campoy (Universitat de Valencia)
Weak convergence of the adaptive Douglas–Rachford algorithm (p. 129)

11:00 Jingwei Liang (Queen Mary University of London)
A Chasing Douglas–Rachford Splittng Method for Feasibility Problem (p. 130)

11:30 Nam Ho-Nguyen (The University of Sydney)
Distributionally Robust Chance-Constrained Programs under Wasserstein Ambiguity (p. 130)

12:00 Yalcin Kaya (University of South Australia)
Some Applications of Multiobjective Optimal Control (p. 130)

14:00 Heinz Bauschke (University of British Columbia, Okanagan)
Displacement mappings and fixed point sets of compositions of projections (p. 128)

15:00 Björn Rüffer (The University of Newcastle)
Make Alternating Projections great again (p. 132)

15:30 Janosch Rieger (Monash University)
A learning-enhanced projection method for solving convex feasibility problems (p. 132)

16:00 Scott Boivin Lindstrom (Hong Kong Polytechnic University)
Computable centering methods for spiraling algorithms and their duals, with motivations from the theory of Lyapunov functions (p. 131)

19. Probability Theory and Stochastic Processes

Join Zoom room

10:00 Ruth J Williams (UC San Diego)
Asymptotic Behavior of a Critical Fluid Model for Bandwidth Sharing with General File Size Distributions (p. 144)

10:30 Andrea Collevecchio (Monash University)
Topics in Random Games (p. 139)

11:00 Han Liang Gan (The University of Waikato)
Stationary distribution approximations for two-island Wright-Fisher models (p. 140)

12:00 Ross Maller (Australian National University)
A remarkable invariance property for the Dickman subordi (p. 142)

12:30 Jeremy Sumner (University of Tasmania)
Uniformization-stable Markov models (p. 144)

14:00 Tim Brown (Monash University)
Revisting stochastic calculus for point processes (p. 139)

14:30 Jesse Goodman (University of Auckland)
How accurate is the saddlepoint approximation for MLEs? (p. 140)

15:00 Libo Li (University of New South Wales)
Optimal stopping problems up to a random time horizon (p. 141)

21. Topology

Join Zoom room

10:00 Norman Do (Monash University)
The structure and geometry of double Hurwitz numbers (p. 150)

10:30 Urs Fuchs (Monash University)
Basic properties of maps tamed by a differential form (p. 150)

11:00 Diarmuid Crowley (The University of Melbourne)
The derivate map for diffeomorphisms of discs (p. 149)

List of Registrants

Current as of Mon 30 Nov 2020

Mr Remy Alexander Adderton (S)	The Australian National University
Mrs Shaymaa Shawkat Al-shakarchi (S)	University of New South Wales
Mr Seamus Albion (S)	The University of Queensland
Assoc Prof Amie Albrecht	University of South Australia
Dr Haya Saeed N Aldosari	University of New South Wales
Mr Salman Alsaeed (S)	University of Wollongong
Mr Salah Alsahafi (S)	University of Technology Sydney
Prof Ben Andrews	Australian National University
Prof Maia Nikolova Angelova	Deakin University
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Ms Lyn Armstrong	Western Sydney University
Dr Jason Atnip	University of New South Wales
Dr José Ayala Hoffmann	The University of Melbourne
Ms Carol Badre (S)	The University of Sydney
Mr Aleksandar Badza (S)	The University of Adelaide
Mr Hamed Baghal Ghaffari (S)	The University of Newcastle
Mr Joseph Baine (S)	The University of Sydney
Miss Ayreena Bakhtawar (S)	La Trobe University
Mx Sanjeeva Balasuriya	The University of Adelaide
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Dr John Banks	The University of Melbourne
Dr Asilata Bapat	Australian National University
Mr Fawwaz Batayneh (S)	University of Queensland
Prof Murray Batchelor	The Australian National University
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Dr Nicholas Beaton	The University of Melbourne
Prof Lisa Beck	Universität Augsburg
Dr Luke Bennetts	The University of Adelaide
Prof Henri Berestycki	EHESS - Ecole des Hautes Etudes en Sciences Sociales
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Mr Alex Bishop (S)	University of Technology Sydney
Dr Bea Bleile	University of New England
Dr Imre Bokor	University of New England
Mr Yossi Bokor (S)	Australian National University
Mr Matteo Bordignon (S)	University of New South Wales Canberra
Dr James Borger	Australian National University
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Prof Peng Chen	sun yat sen university
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Dr Norman Do	Monash University
Mr Illia Donhauzer (S)	La Trobe University
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Prof Jerome Droniou	Monash University
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Prof Yihong Du	University of New England
Mr Matt Dufty	None
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Dr Maureen Edwards	University of Wollongong
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Prof Terence Mills	La Trobe University
Mr Adrian Miranda (S)	Macquarie University
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Prof Alexander Molev	The University of Sydney
Dr Kerri Morgan	Deakin University
Dr Anthony Morphett	The University of Melbourne
Miss Ellena Moskovsky (S)	Monash University
Mr Rajnesh Krishnan Mudaliar (S)	University of New England
Dr Alexander Mundey	University of Wollongong
Mr Ryan Murphy (S)	Queensland University of Technology
Prof Mary Myerscough	The University of Sydney
Mr GyeongHyeon Nam (S)	The University of Queensland
Mrs Ravindi Nanayakkara (S)	La Trobe University
Dr Vinoth Nandakumar	The University of Sydney
Assoc Prof Mark Nelson	University of Wollongong
Ms Trang Thi Thien Nguyen (S)	University of South Australia
Mr Cuong Nguyen Duy (S)	Federation University Australia
Dr Wenjie Ni	University of New England
Dr James Ashton Nichols	Australian National University
Dr Yuri Nikolayevsky	La Trobe University
Mr Branko Nikolic (S)	Macquarie University
Prof Paul Norbury	The University of Melbourne
Dr Gennady Arshad Notowidigdo	University of New South Wales
Mr Medet Nursultanov	The University of Sydney
Dr Suil O	SUNY Korea
Assoc Prof Malgorzata Marzena O'Reilly	University of Tasmania
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Mr MUSTAPHA OMARI	Canberra Institute of Technology
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Prof Terence OḰane	CSIRO
Ms Xueyu Pan (S)	Monash University
Dr Bregje Pauwels	The University of Sydney
Prof Tracy Payne	Idaho State University
Prof John Pegg	University of New England
Miss Vinesha Peiris (S)	Swinburne University of Technology
Dr Oscar Peralta	The University of Adelaide
Mr Toan Pham (S)	The University of Queensland
Mx João Vitor Pinto e Silva (S)	The University of Newcastle
Dr Chayne Planiden	University of Wollongong
Dr Giorgio Poggesi	The University of Western Australia
Prof Philip Keith Pollett	University of Queensland
Dr Ting Kei Pong	Hong Kong Polytechnic University
Dr Pierre Portal	Australian National University
Dr John Power	Macquarie University
Prof Cheryl Praeger	The University of Western Australia
Dr Peter F Price	Defence Science and Technology Group
Prof Geoff Prince	La Trobe University
Dr Artem Pulemotov	The University of Queensland
Prof Jessica Purcell	Monash University
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Mr ZHIHAO QIAO (S)	The University of Queensland
Dr Thomas Quella	The University of Melbourne
Dr Courtney Rose Quinn	CSIRO
Mr Georges Radohery (S)	UNSW Sydney
Mr Vsevolod Rakita (S)	Technion, Israel Institute of Technology
Prof Arun Ram	The University of Melbourne
Prof Jacqui Ramagge	The University of Sydney
Prof Chris Rasmussen	San Diego State University
Dr Jorgen Rasmussen	The University of Queensland
Mrs Nishanthi Raveendran (S)	Macquarie University
Dr Christopher Raymond	The Australian National University
Dr Sophie Raynor	Macquarie University
Dr Björn Rüffer	The University of Newcastle
Dr Colin David Reid	The University of Newcastle
Prof Simon Riche	Université Clermont Auvergne
Dr David Ridout	The University of Melbourne
Dr Janosch Rieger	Monash University
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Dr Ian Roberts	Charles Darwin University
Prof John Roberts	University of New South Wales
Dr Lindon Roberts	Australian National University
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Dr David Robertson	University of New England
Dr Marcy Robertson	The University of Melbourne
Dr Melanie Robertson-Dean	University of New England
Mr Christopher P Rock (S)	UNSW Sydney
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Dr Fred Roosta	University of Queensland
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Mr Rajiv Roy (S)	Stony Brook University
Dr Jan Rozendaal	Institute of Mathematics, Polish Academy of Sciences

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Prof Shoham Sabach	Technion, Israel Institute of Technology
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Mr Thomas Scheckter (S)	University of New South Wales
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Dr Jelena Schmalz	University of New England
Prof Christopher Schneider	University of Applied Sciences Jena
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Dr Travis Scrimshaw	The University of Queensland
Dr Katherine Seaton	La Trobe University
Dr Amanda Shaker	La Trobe University
Ms Himani Sharma (S)	The Australian National University
Dr Sergiy Shelyag	Deakin University
Ms Wenhui Shi	Monash University
Prof Igor Shparlinski	UNSW Sydney
Prof Harvinder Sidhu	University of New South Wales
Dr Leesa Sidhu	University of New South Wales Canberra
Dr Adam Sikora	Macquarie University
Dr Rinovia Simanjuntak	Institut Tekonologi Bandung
Prof Aidan Sims	University of Wollongong
Dr Brailey Sims	The University of Newcastle
Dr Satyanand Singh	NYCCT of CUNY
Dr Anja Slim	Monash University
Prof Bob Smith	Aalto University
Mr Albert Christian Soewongsono (S)	University of Tasmania
Dr Nikki Sonenberg	The Alan Turing Institute
Mr Angus Southwell (S)	Monash University
Dr Jonathan Spreer	The University of Sydney
Miss Abirami Srikumar (S)	UNSW Sydney
Dr Peter Stacey	La Trobe University
Dr Eva Stadler	UNSW Sydney
Ms Valeriia Starichkova (S)	UNSW Canberra
Dr Ralf Steiner	NWF (LI)
Prof Yury Stepanyants	University of Southern Queensland
Mr Kyle Jacob Stevens (S)	The University of Newcastle
Mr Joshua Stevenson (S)	University of Tasmania
Mr John Etienne Stewart (S)	Monash University
Dr Tim Stokes	University of Waikato
Prof Yvonne Stokes	The University of Adelaide
Mr Alan Stoneham (S)	UNSW Sydney
Prof Luchezar Stoyanov	The University of Western Australia
Prof Ross Howard Street	Macquarie University
Ms Michelle Strumila (S)	The University of Melbourne
Dr Nadia Sukhorukova	Swinburne University of Technology
Dr Jeremy Sumner	University of Tasmania
Mr Xifu Sun (S)	Australian National University
Dr Nicole Sutherland	The University of Sydney
Mr Daniel Sykes (S)	University of New England
Dr Melissa Tacy	The University of Auckland
Dr Matthew Tam	The University of Melbourne

Dr Gabriele Tartaglino-Mazzucchelli	The University of Queensland
Dr Mehdi Tavakol	The University of Melbourne
Prof Peter Taylor	The University of Melbourne
Mr Giacomo Tendas (S)	Macquarie University
Dr James Tener	The Australian National University
Prof Tom ter Elst	University of Auckland
Dr Venta Terauds	University of Tasmania
Prof Natalie Thamwattana	The University of Newcastle
Dr Guo Chuan Thiang	The University of Adelaide
Ms Emily Thompson (S)	Monash University
Dr Lauren Thornton	University of the Sunshine Coast
Prof Stephan Tillmann	The University of Sydney
Prof Chris Tisdell	University of New South Wales
Dr Stephan Tornier	The University of Newcastle
Mr Kane Townsend (S)	The University of Sydney
Prof Thanh Tran	University of New South Wales
Dr TriThang Tran	The University of Melbourne
Dr Hayden Tronnolone	Flinders University
Assoc Prof Timothy Trudgian	UNSW Canberra
Prof Neil Trudinger	Australian National University
Dr Ilknur Tulunay	UNSW,UTS,ACU
Dr Katharine Turner	Australian National University
Prof Reidun Twarock	University of York
Dr Julien Ugon	Deakin University
Mr Daniel Uteda (S)	The University of Melbourne
Prof Enrico Valdinoci	The University of Western Australia
Dr Raymond van Bommel	MIT
Dr Pieter Hubert van der Kamp	La Trobe University
Dr Robert Van Gorder	University of Otago
Prof Petrus van Heijster	Wageningen University and Research
Prof Mathai Varghese	The University of Adelaide
Mr Frank Vega	CopSonic
Mr Ivo De Los Santos Vekemans (S)	Australian National University
Assoc Prof Vanessa Venturi	University of New South Wales
Ms Paula Verdugo (S)	Macquarie University
Prof Dominic Verity	Macquarie University
Dr Bryan Wang	Australian National University
Ms Jie Wang (S)	Federation University Australia
Prof Lu Wang	California Institute of Technology
Miss Rong Wang (S)	University of New England
Prof Xu-Jia Wang	Australian National University
Dr Yuguang Wang	Max Planck Institute; UNSW
Prof Ian Wanless	Monash University
Prof Lesley Ward	University of South Australia
Prof Ole Warnaar	The University of Queensland
Ms Rachel Watkins	Department of Education
Dr Simon Watt	UNSW Canberra
Prof Martin Wechselberger	The University of Sydney
Dr Mitchell Welch	University of New England
Dr Glen Wheeler	University of Wollongong
Dr Valentina-Mira Wheeler	University of Wollongong
Dr Aaron Wiegand	University of the Sunshine Coast
Mr Giulian Wiggins (S)	The University of Sydney
Prof Ruth J Williams	UC San Diego
Prof George Willis	The University of Newcastle
Ms Sinead Wilson (S)	The Australian National University
Prof David Wood	Monash University
Dr Haotian Wu	The University of Sydney
Ms Yuhan Wu (S)	University of Wollongong

Dr Aihua Xia	The University of Melbourne
Prof Hong-Kun Xu	Hangzhou Dianzi University
Dr Ting Xue	The University of Melbourne
Dr Oded Yacobi	The University of Sydney
Dr Yaping Yang	The University of Melbourne
Mr Kam Hung Yau (S)	University of New South Wales
Mr Liam Yemm (S)	Monash University
Dr David Yost	Federation University Australia
Prof Xiaoming Yuan	The University of Hong Kong
Ms Adriana Zanca (S)	The University of Melbourne
Mrs Ashwaq Zarban (S)	UNSW Sydney
Dr Erchuan Zhang	Edith Cowan University
Dr Lele (Joyce) Zhang	The University of Melbourne
Dr Yang Zhang	The University of Sydney
Dr Yinan Zhang	Australian National University
Dr Zhou Zhang	The University of Sydney
Dr Liangyi Zhao	University of New South Wales
Miss Zhao Mei Zheng (S)	The University of Sydney
Dr Zongzheng Zhou	Monash University
Dr Jonathan Julian Zhu	Australian National University
Assoc Prof Ilze Ziedins	The University of Auckland
Dr Nan Zou	Macquarie University

Abstracts

1. Plenary

1.1. Clocks and cars and coded stars, and other complex things

Rowena Ball (The Australian National University)

Thu 10 December 202010:00

Assoc Prof Rowena Ball

In this lecture for the inaugural Mandawuy Yunupingu session I shall pay my respects to the Seven Sisters of the night sky, by talking you along a journey through maths and science songlines of cultures and histories. On this adventure first we meet some of the institutional gatekeepers of mathematics, and from them we learn how important advances in maths were driven by the economic imperatives of applied, real-world problems, such as the need to finance voyages of colonial invasion, robbery and slavery. We then take a tour of some lands of the Seven Sisters, where I tell stories about maths I do with school students of First Nations. Following a songline – literally – I shall describe current research on an Indigenous mathematical transform. As we move towards a broader and more inclusive understanding of mathematics, freeing us from the cultural confines of the white male priesthood that has been the dominant paradigm, we may begin to see exciting new research opportunities at the interface.

1.2. On the minimization of convex, variational integrals of linear growth

Lisa Beck (Universität Augsburg)

Tue 8 December 202018:00

Prof Lisa Beck

We study the minimization of functionals of the form

$$u \mapsto \int_\Omega f(\nabla u)\, dx$$

with a convex integrand f of linear growth (such as the area integrand), among all functions in the Sobolev space $\mathrm{W}^{1,1}$ with prescribed boundary values. Due to insufficient compactness properties of these Dirichlet classes, the existence of solutions does not follow in a standard way by the direct method in the calculus of variations and might in fact fail, as it is well-known already for the non-parametric minimal surface problem. In such cases, the functional is extended suitably to the space BV of functions of bounded variation via relaxation, and for the relaxed functional one can in turn guarantee the existence of minimizers. However, in contrast to the original minimization problem, these BV minimizers might in principle have interior jump discontinuities or not attain the prescribed boundary values.

After a short introduction to the problem, I want to focus on the question of regularity of BV minimizers. In past years, Sobolev regularity was established provided that the lack of ellipticity – which is always inherent for such linear growth integrands – is mild, while, in general, only some structure results seems to be within reach. In this regard, I will review several results which were obtained in cooperation with Miroslav Bulíček (Prague), Franz Gmeineder (Bonn), Erika Maringová (Vienna), and Thomas Schmidt (Hamburg).

1.3. Reaction-diffusion systems and the Covid 19 epidemics

Henri Berestycki (EHESS - Ecole des Hautes Etudes en Sciences Sociales)

Thu 10 December 202018:40

Prof Henri Berestycki

The classical SIR type models of epidemiology with spatial spreading take the form of integro-differential or reaction-diffusion systems. Such systems also arise in a variety of other contexts. For instance, they yield a remarkable insight in the study of collective behaviors such as riots. In this lecture, I will first recall the classical setting and then discuss a general framework for this type of systems that we call “Activity / Susceptibility” systems. In the second part of my talk, I will present a new model that describes the influence of roads on the spread of epidemics. I will also show applications of these ideas to data of the current Covid-19 epidemic. I report here on joint works with Samuel Nordmann and Luca Rossi for the first part, with Jean-Michel Roquejoffre and Luca Rossi for the model with roads and with Lionel Roques et al. for the study of data.

1.4. Some special geometries in dimension five

Michael Eastwood (The University of Adelaide)

Wed 9 December 202018:00
Prof Michael Eastwood

When thinking of differential geometry, it is Riemannian geometry (based on distance) that first springs to mind. However, already in two dimensions, there are many other notions of geometry (useful in cartography). In higher dimensions, life becomes very interesting indeed: there are, for example, two different five-dimensional geometries with exceptional G2 symmetry, whatever that means (to be explained in this talk).

1.5. Geometric evolution equations allowing change of topology

Gerhard Huisken (Tuebingen University)

Wed 9 December 202019:10
Prof Gerhard Huisken

Geometric evolution equations such as Ricci-flow of Riemannian metrics or mean curvature flow and inverse mean curvature flow of hypersurfaces can provide powerful insight into the underlying manifolds when it is possible to extend solutions beyond singularities in a way that keeps control of topological changes. The lecture gives an overview of recent techniques and results with a view to similarities and differences between these non-linear parabolic flows.

1.6. Riemann-Hilbert Problems

Nalini Joshi (The University of Sydney)

Wed 9 December 202019:10
Prof Nalini Joshi

A Riemann-Hilbert problem asks how to construct analytic functions from jump conditions given on specific contours in the complex plane. It is a remarkably important problem in physical applications, such as solar astrophysics. The classical question arose from the problem of surjectivity of the monodromy map in the theory of Fuchsian systems, formulated as Hilbert's 21st problem. In this talk, I will describe the corresponding problem arising from q-difference equations, studied by Birkhoff and his students more than 100 years ago, and give some new results.

1.7. Back to the Future: ranking and selection

Kerrie Mengersen (Queensland University of Technology)

Tue 8 December 202012:30
Prof Kerrie Mengersen

This year, AustMS is being hosted by my alma mater, the University of New England. My PhD research focused on 'ranking and selection', under the supervision of Dr Eve Bofinger. In this presentation, I will discuss the ongoing relevance and challenges of ranking and selection, from both methodological and applied perspectives. Taking a Bayesian approach, I will touch on issues of model formulation, prior specification and hypothesis testing, with applications in sport, cancer mapping, genomics and organisational benchmarking. This research has been undertaken in collaboration with a range of colleagues who will be acknowledged in the presentation.

1.8. Manin matrices, Casimir elements and Sugawara operators

Alexander Molev (The University of Sydney)

Wed 9 December 202011:10
Prof Alexander Molev

A family of quadratic algebras associated with quantum groups emerged in the work of Yuri Manin in the late 1980s. In the simplest example, such an algebra arises from 2×2 matrices whose 'coaction' preserves the 'quantum plane' with generators x, y and the relation $yx = qxy$. We will discuss basic properties of the algebras and show that many classical identities have their counterparts for the associated Manin matrices. They include the MacMahon Master Theorem, Newton Identities and Cayley—Hamilton Theorem. We will also consider applications of these properties to descriptions of Casimir elements and Sugawara operators for the general linear Lie algebras.

1.9. Research on Learning and Teaching University Mathematics: Where we are and where we might go next

Chris Rasmussen (San Diego State University)

Wed 9 December 202010:00
Prof Chris Rasmussen

In this talk I begin with a brief overview of what we know about the teaching and learning of calculus in the United States. In particular, I highlight findings from two large US national studies of the precalculus through calculus sequence . Next, I review what we know about the effects and uptake of research-based instructional strategies at the university level. I then reflect on new directions for the broader field of research in university mathematics education. These new directions include expanding the notion of inquiry, research related to departmental and institutional change, and research that centers issues of equity and social justice.

1.10. Mathematical Virology: Geometry as a key to the discovery of novel anti-viral solutions

Reidun Twarock (University of York)

Tue 8 December 202019:10
Prof Reidun Twarock

Viruses encapsulate their genetic material into protein containers that act akin to molecular Trojan horses, protecting viral genomes between rounds of infection and facilitating their release into the host cell environment. In the majority of viruses, including major human pathogens, these containers have icosahedral symmetry. Mathematical techniques from group, graph and tiling theory can therefore be used to better understand how viruses form, evolve and infect their hosts, and point the way to novel antiviral solutions. In this talk, I will present a theory of virus architecture, that contains the seminal Caspar Klug theory as a special case and solves long-standing open problems in structural virology. I will also introduce mathematical models of symmetry breaking in viral capsids and discuss their consequences for our understanding of more complex viral geometries. By combining these geometric insights with a range of different mathematical and computational modelling techniques, I will demonstrate how viral life cycles can be better understood through the lens of viral geometry, and how such insights can act as drivers of discovery of novel anti-viral solutions.

1.11. Spatiotemporal pattern formation from non-autonomous reaction-diffusion systems

Robert Van Gorder (University of Otago)

Tue 8 December 202013:40
Dr Robert Van Gorder

First described by A. M. Turing in the 1950's, the eponymous "Turing instability" is one of the most commonly employed instability mechanisms for studying the transition from spatially homogeneous states to heterogeneous spatial or spatiotemporal states in reaction-diffusion systems. In this talk, I discuss the case where the underlying reaction-diffusion system is non-autonomous in some manner. The standard Turing analysis, which relies on temporal eigenvalues, breaks down for such problems, so a new approach is needed to study the onset of instability. After first describing a generalization of the Turing analysis to the non-autonomous setting, I apply this generalized analysis to better understand instabilities emergent due to a variety of non-autonomous mechanisms, including time-varying diffusion coefficients, time-varying reaction rates, and time-dependent transitions between reaction kinetics through base states which change in time (such as heteroclinic connections between unique steady states, or limit cycles). The Benjamin-Feir instability provides an alternate route to pattern formation through the diffusive instability of a limit cycle rather than a steady state, and I will describe the non-autonomous analogue of this mechanism, as well. To conclude, I will briefly describe how the approach can be used to study more complex dynamics emergent from pattern formation on evolving space domains, pattern formation on temporal networks (networks which change their topology over time), and the use of a time-varying temperature profile in modifying Turing patterns.

For those interested, this talk will draw on my recent publications

R. A. Van Gorder, Proceedings of the Royal Society A 476(2238) (2020) 20200003
R. A. Van Gorder, Proceedings of the Royal Society A 476(2240) (2020) 20200356
R. A. Van Gorder, V. Klika, A. L. Krause, Journal of Mathematical Biology (in press) arXiv:1904.09683

1.12. Modelling patient pathways to improve health care delivery

Ilze Ziedins (The University of Auckland)

Thu 10 December 202011:40
Assoc Prof Ilze Ziedins

Providing timely health care is crucial, yet patients may experience long delays in receiving treatment. Are there ways in which these delays could be reduced? Could the existing capacity be used in different ways? I will discuss some of the challenges in answering these questions from the perspective of stochastic networks and queueing theory, and give examples of both theoretical and simulation based approaches. Examples will include ICU modelling, cancer patient pathways, priority regimes, and most recently, modelling for Covid-19.

2. Algebra

2.1. Geodesic Growth in Virtually Abelian Groups

Alex Bishop (University of Technology Sydney)

Tue 8 December 202015:50
Alex Bishop

One of the most famous results in geometric group theory is Gromov theorem which completely classifies the groups with polynomial volume growth. Bridson, Burillo, Elder and Šunić (2012) asked if such a classification exists for geodesic growth. Towards this question, they provided a sufficient condition for a virtually abelian group to have polynomial geodesic growth (with respect to a specific generating set). In this talk, we take the next step in this study and completely characterise the geodesic growth for all virtually abelian groups. Moreover, we provide an example of a virtually 2-step nilpotent group with polynomial geodesic growth.

2.2. Some comments on group isomorphism

Heiko Dietrich (Monash University)

Tue 8 December 202014:50
Assoc Prof Heiko Dietrich

I will report on some recent progress on the group isomorphism problem; most of this is joint work with James Wilson (Colorado State University, USA).

2.3. Transformation representations of semigroups

James East (Western Sydney University)

Thu 10 December 202015:00
Dr James East

The *degree* of a finite semigroup S is the minimum n such that S can be faithfully represented by transformations of an n-set. This talk will discuss some recent work calculating degrees of various classes of semigroups, including null semigroups, nilpotent semigroups, rectangular bands and sandwich semigroups. Some interesting combinatorial objects play an important role, including integer compositions and hypergraph colourings.

This is joint work with Peter Cameron, Des FitzGerald, James Mitchell, Luke Pebody and Thomas Quinn-Gregson.

2.4. What is a $\mathcal{C}$-Cayley position-faithful linear time computable group?

Murray Elder (University of Technology Sydney)

Tue 8 December 202016:20
Dmitry Berdinsky, Murray Elder, Prohrak Kruengthomya

I will answer this question by explaining each of the terms used, then give some examples, and define an even more general class called $\mathcal{C}$-Cayley polynomial time computable. I will not however answer the obvious follow-on question "and why would you care?"

2.5. Conjugacy depth function for lamplighter groups is exponential

Michal Ferov (The University of Newcastle)

Wed 9 December 202014:50
Dr Michal Ferov

Conjugacy depth function of a group quantifies how difficult it is to distinguish conjugacy classes by inspecting finite quotients of the group. Informally speaking, it measures how deep (in terms of word length) one needs go within the lattice of subgroups of finite index to be able to determine whether or not two words represent conjugate elements.

In general, apart from free groups, surface groups, and virtually nilpotent groups, asymptotic properties of conjugacy depth functions is not known. We construct lower and upper bounds for wreath products of abelian groups and as a consequence we show that for lamplighter groups the conjugacy depth function is exponential. (joint work with Mark Pengitore)

2.6. Some curious semirings

Marcel Jackson (La Trobe University)

Thu 10 December 202013:30
Dr Marcel Jackson

Finite semirings hold unexpectedly rich equational properties, even in the case where the additive operation is idempotent (and commutative, as is standardly assumed). Semirings formed over finite groups already provide a number of interesting examples including unusually slow (but unbounded) growth of equational complexity. Another instance is an ostensibly innocuous 3-element semiring that turns out to have NP-hardness for membership in its variety: possibly the simplest known example of its kind. This research continues a theme of work based around encodings of hypergraphs in algebraic objects.

2.7. Probabilities of properties

James Mathew Koussas (La Trobe University)

Thu 10 December 202014:00
Mr James Mathew Koussas

The probability of a property holding in a class of finite relational structures of a finite signature can be defined as the limit of the proportion of labelled or unlabelled n-element structures satisfying the given property. We will look at some sufficient conditions for these definitions coinciding and probabilistic results on some well known classes (with an emphasis on relation algebras).

2.8. An Algebraic Interpretation of Super Catalan Numbers

Kevin Limanta (University of New South Wales)

Thu 10 December 202014:30
Mr Kevin Limanta

In this talk, I will give a brief introduction of the super Catalan numbers

$$S(m,n) = \frac{(2m)!(2n)!}{m!n!(m+n)!}$$

and their curious connection to the "polynomial integration", whose meaning will be made clear in the talk, over the unit circle

$$S = \{(x,y) \in \mathbf{F}^2 \ : \ x^2 + y^2 = 1\}$$

where $\mathbf{F}$ is any finite field of characteristic not two. This technology is the basic ingredient of Fourier analysis, done in a completely algebraic way.

2.9. Groups of small order type

Xueyu Pan (Monash University)

Tue 8 December 202015:20

Ms Xueyu Pan

For my MPhil project I investigate groups whose orders factorise in few primes. Classifications of these groups exist in the literature, but it is often difficult to extract the results. The aim of my thesis is to describe these classifications in a unified, modern language. An important and practical aspect of my new descriptions is that they lead to efficient algorithms for enumerating, constructing, and identifying groups of these orders.

2.10. Elementary Groups

João Vitor Pinto e Silva (The University of Newcastle)

Wed 9 December 202013:50

Mx João Vitor Pinto e Silva

Locally compact groups show up naturally in many areas of mathematics and one of the ways to study this class is understanding its connected component, which is a normal, closed, connected subgroup, and the quotient under the connected component, which is a totally disconnected group. The class of elementary groups shows up naturally when studying totally disconnected locally compact groups and has inside it many classes of other topological groups. The talk will be about how this class of groups can be defined, results related to it and open questions that we are working with.

2.11. Abelian chief factors of locally compact groups

Colin David Reid (The University of Newcastle)

Wed 9 December 202013:20

Dr Colin David Reid

Recent work in the theory of locally compact second-countable (l.c.s.c.) groups has highlighted the importance of chief factors, meaning pairs of closed normal subgroups K/L such that no closed normal subgroups lie strictly between K and L. In particular, the group K/L is then topologically characteristically simple, meaning it has no proper nontrivial closed subgroup that is preserved by all automorphisms. I will present a classification of the abelian l.c.s.c. topologically characteristically simple groups: these all occur as chief factors of soluble groups, and naturally fall into five families with a few parameters. Each family has a straightforward characterization within the class of abelian l.c.s.c. groups, without directly invoking the property of being topologically characteristically simple.

2.12. Orbit Isomorphic Skeleton Groups

Subhrajyoti Saha (Monash University)

Wed 9 December 202014:20

Dr 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. 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 which was introduced in 1980 by Leedham-Green and Newman.

A finite p-group of order p^n and nilpotency class c has *coclass* $r = n - c$. 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. It is known 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. An isomorphism between skeleton groups induced by the automorphism of S is called an orbit isomorphism; this situation is particularly interesting since it means that the construction of skeleton groups up to isomorphism depends solely on the structure of S. We investigated when all isomorphisms between skeleton groups can be realised by orbit isomorphisms. Here we present some general results of this flavor including some interesting special cases and applications.

2.13. Ordered semigroups and relation algebra.

Tim Stokes (University of Waikato)

Thu 10 December 202013:00
Dr Tim Stokes

It is well-known that algebras of permutations under composition and inversion are axiomatised as the class of groups: this is Cayley's Theorem. Relation algebra concerns the axiomatisation of algebras of binary relations under various combinations of natural operations and relations (such a combination is called a signature; for example composition and the inclusion order). Most natural signatures of relation algebras do not give nice axiomatisations like groups: they have no finite basis for their laws! But there are some rare exceptions: one is algebras of relations under composition and the inclusion order, which are nothing but ordered semigroups as shown by Zareckiĭ in 1959. We give a "demonic" version of this result, in which composition and inclusion are replaced by their demonic varaints (which are motivated from Computer Science), and look at what happens when we mix the angelic with the demonic. This is joint work with Robin Hirsch (UCL) and Szabolcs Mikulas (Birkbeck).

2.14. Think globally, act locally

Stephan Tornier (The University of Newcastle)

Wed 9 December 202012:50
Dr Stephan Tornier

Let G be a group acting on a regular tree. The 'local' actions that vertex stabilisers in G induce on balls around the fixed vertex are innately connected to the 'global' structure of G. I demonstrate this relationship and define a particularly accessible class of groups acting on (locally finite) regular trees by 'prescribing' said local actions, following Burger-Mozes. Being defined solely in terms of finite permutation groups, these groups allow us to introduce computational methods to the world of locally compact groups: I will outline the capabilities of a recently developed GAP package that provides methods to create, analyse and find suitable local actions. Joint work with Khalil Hannouch.

3. Applied and Industrial Mathematics

3.1. A mathematical model for the activated sludge process

Salman Alsaeed (University of Wollongong)

Tue 8 December 202015:50
Mr Salman Alsaeed

Mathematical modelling of the activated sludge process (ASP) dates back to the late 1960s and early 1970s. One of the main disadvantages of the activated sludge process is the production of excessive amounts of sludge. Since sludge disposal can represent 50–60

3.2. Complex resonant ice shelf vibrations

Luke Bennetts (The University of Adelaide)

Thu 10 December 202016:30
Dr Luke Bennetts

Ice shelves vibrate in response to ocean waves, and the resulting stresses and strains have been connected to rift propagation, calving, ice quakes and even catastrophic disintegration. An ice shelf vibration model is considered in which the shelf thickness and seabed vary over distance. It is shown that both the spectral and temporal responses of the shelf to wave forcing can be approximated using so-called complex resonances. The complex resonances are connected with real-valued resonances when the shelf and sub-shelf cavity are uncoupled from the open ocean, and these are used as starting points for a homotopy to capture the complex resonances.

3.3. A Markov-Chain Monte-Carlo approach to estimation of parameters and uncertainty in Thermogravametric Analysis models

Matthew Berry (University of Wollongong)

Wed 9 December 202016:20
Mr Matthew Berry

Thermogravemtric analysis (TGA) is an experimental technique that is used to measure reaction rates of various process. Understanding these reaction rates is useful so that we can enhance the recyclability of filter cake generated from Basic Oxygen Steelmaking. Estimating the kinetic parameters from the TGA allows us to use these reactions to predict behaviour in large stockpiles. In examining these parameters it is not only important to get estimates for the exact values, but to also estimate the uncertainty. Current methods of parameter estimation focus more on obtaining individual estimates and determining uncertainty is done around those maximum likelihood estimates.

The method we propose uses a Markov-chain Monte-Carlo (MCMC) algorithm. The MCMC algorithm allows us to generate a sample of possible kinetic parameters that can be used to determine probabilities of a stockpile igniting. This method allows estimates to be obtained after one TGA experiment rather than the standard approach that requires multiple runs.

3.4. Exact and Numerical solutions of nonlinear Fisher-KPP reaction-diffusion equations: Design of marine protection areas.

Philip Broadbridge (La Trobe University)

Thu 10 December 202014:00
Prof Philip Broadbridge

Using nonclassical symmetry reduction, equations of Fisher-KPP type can be solved exactly on 2D domains subject to lethal Dirichlet boundary conditions. This leads to the critical domain size without any linear approximation.

Comparisons with fish recapture data show that diffusion (resulting from Brownian motion) is a rough approximation. The domain size can be reduced when the fish do not move randomly but are less mobile in the safe central area. Exact solutions to the nonlinear PDE can still be constructed when the diffusivity depends on location.

Another appropriate approach, validated on a recapture data set by log-likelihood improvement, is to account for non-normal displacement distributions in a two-speed mixture model to account for distinct phenotypes of station-keepers and travellers. The resulting coupled system of reaction-diffusion equations can at least be solved in the linear approximation at low population densities to find the critical domain size, even when there are disconnected patches of no-take areas. Between the safe patches, there is a negative population growth rate due to harvesting. The lethal boundary condition on no-take domains is weakened to continuity of density and continuity of flux but this does not greatly reduce the individual critical domain size. Beyond the minimal aim of species survival, advantages of multiple protected patches are (i) hedging against localised environmental disasters, (ii) promoting genetic diversity, (iii) greater spillover to the fishery by out-flux from an assured supply.

This work is in collaboration with Ashleigh Hutchinson (WITS Univ. South Africa), Bruce Mann (Univ. Kwa-Zulu Natal, South Africa) and Xia Li (La Trobe Univ.)

3.5. Analytic solution of various reaction-diffusion models

Bronwyn Hajek (University of South Australia)

Thu 10 December 202013:00
Dr Bronwyn Hajek

Nonlinear reaction-diffusion equations are used to describe many different processes in biology and chemistry, for example, heat transfer, population dynamics, cell proliferation, and chemical reactions. While analytic solutions are often extremely useful, they can be particularly difficult and sometimes impossible to construct for nonlinear PDEs. In this talk, I'll show how the nonclassical symmetry method can be used to find analytic solutions to nonlinear reaction-diffusion equations. In particular, I'll show solutions to two different problems, one in math biology and one in combustion.

3.6. Neuromorphic Modelling of Disease Models

Tara Julia Hamilton (University of Technology Sydney)

Fri 11 December 202010:30

Assoc Prof Tara Julia Hamilton

Neuromorphic Computing is focused on the development of technology based on biological neural computation. This type of bio-inspired modelling, however, can also be employed to simulate cellular and small network models to try and understand the pathology of particular diseases. Here we will explain the Neuromorphic approach and how it can be implemented in concert with mathematical modelling to better understand the physical processes underlying particular disease models.

3.7. Dynamic Bayesian network models of climate teleconnections

Dylan Harries (CSIRO)

Wed 9 December 202015:50

Dylan Harries, Terence J. O'Kane

Teleconnections – large scale modes of low-frequency variability in the Earth's climate system – are key drivers of weather and climate conditions over large portions of the globe. Interactions between modes play an important role in determining their dynamics and evolution. Accurately understanding the structure of these relationships, and their responses to external forcing, is therefore essential for producing reliable forecasts as well as longer term projections. Probabilistic graphical models are a natural framework in which to represent dependence relationships between teleconnections, and recently graphical modelling methods have been applied for the purpose of learning the structure of reduced order models of major teleconnections. However, most such models do not allow for non-homogeneity in the network structure and parameters, as is expected to be necessary to represent the real, non-stationary climate system, and the constraint-based algorithms employed generally make robust assessment of model uncertainties difficult. In this talk, we report on applications of homogeneous and non-homogeneous dynamic Bayesian networks to learning interaction networks between teleconnections in historical reanalysis data. A fully Bayesian approach to model selection is employed, allowing for a principled quantification of parameter and model uncertainties. The resulting models inferred in this way are compared across several reanalysis products to identify differences between reanalyses in the representation of important physical processes. When taken together, these observed networks provide a set of reference structures and relationships against which free-running climate models can be evaluated.

3.8. Dynamics of illegal harvest

Matthew Holden (The University of Queensland)

Wed 9 December 202012:50

Dr Matthew Holden

Illegal harvest of wildlife (poaching) is one of the greatest threats to biodiversity. Most countries try to reduce poaching by increasing law enforcement to catch and punish poachers. But despite best efforts from police, poaching is more frequent now than ever. In this talk, we present ordinary differential equation models of poachers and wildlife, to explore why law-enforcement has failed to stem the poaching problem. We then use these models to project the performance of controversial, alternative, management actions, such as campaigns to reduce consumer demand for illegal wildlife products and legalising the trade of these products.

3.9. Linking Item Response Theory to algorithm evaluation

Sevvandi Priyanvada Kandanaarachchi (RMIT University)

Fri 11 December 202015:30

Dr Sevvandi Priyanvada Kandanaarachchi

Item Response Theory (IRT) is a paradigm within the field of Educational Psychometrics, that is used to assess student ability and test question difficulty and discrimination power. IRT has recently been applied to evaluate machine learning algorithm performance on a classification dataset. Here, we present a modified IRT-based framework for evaluating a portfolio of algorithms across a repository of datasets, while eliciting a suite of richer characteristics such as stability, effectiveness and anomalousness, that describe different aspects of algorithm performance.

3.10. Optimal partitioning of photovoltaic modules on a curved solar collector

Maria Kapsis (University of South Australia)

Wed 9 December 202014:20

Miss Maria Kapsis, Associate Professor Amie Albrecht and Associate Professor Peter Pudney

The Australian Technology Network (ATN) group of universities designed and built a solar car to participate in the 2019 Bridgestone World Solar Challenge. The car is powered by 29 photovoltaic modules on its top surface. To get a useful voltage from the solar collector, modules are connected in series. However, the power generated by a group of modules in series is limited by the module with the lowest irradiance.

Irradiance depends on the angle between the sun and the cell normal, which is influenced by the curvature of the collector and the position of the sun relative to the car. If all of the modules were facing the same direction then each module would receive the same irradiance and there would be no 'series mismatch' losses, but the solar panel is curved for aerodynamic efficiency.

Our challenge was to partition the modules into groups so that the energy generated by the solar collector is maximised during a six-day journey across Australia. A Mixed-Integer Programming formulation, using a simplified model of the power generated by candidate module groups, was unable to find results for more than four percent of the 3022 km journey. A more realistic model of module behaviour required numerical search methods to calculate module powers, increasing the calculation time. Using a Cross-Entropy Optimisation method, we were able to find good solutions to the six-day problem.

3.11. A DYNAMIC MECHANISTIC MODEL OF HYDROGEN-METHANOGEN PRODUCTION IN THE RUMEN WITH A RECYCLE

Ashfaq Khan (RMIT University)

Tue 8 December 202015:20

Dr Ashfaq Khan

A DYNAMIC MECHANISTIC MODEL OF HYDROGEN-METHANOGEN PRODUCTION IN THE RUMEN WITH A RECYCLE MARK NELSON AND ASHFAQ KHAN

Recently a mechanistic model estimating methane and hydrogen production in a rumen has been developed by Wang et al (2016). The authors found that increase in fractional passage rate resulted in increase in growth rate of methanogens at steady- state. In our model we extend this approach to include a recycle stream to model the chewing of the cud in cattle. We also examine dynamics in the rumen with different fractional passage.

3.12. van der Waals interactions between ferric ions and MOF pores

Kirsten Louw (University of South Australia)

Thu 10 December 202014:30

Miss Kirsten Louw

In mineral processing, determining the concentration of ferric ions in an analyte solution is important to optimise copper yield. A new ferric ion senor is being developed that consists of an optic fibre that has a thin polymer/metal-organic framework (MOF) layer coating in a section of the fibre that has been cut away. After submersion in the analyte solution, a light pulse through the optic fibre can be used to indicate the number of ferric ions that have diffused into pores in the MOF crystals, and subsequently the concentration of ferric ions in the analyte solution can be inferred. In this talk I will describe calculations of the van der Waals interactions between the MOF pores and the hexa-aqua iron.

3.13. Emergent behaviour in an adversarial synchronisation and swarming model

Timothy McLennan-Smith (University of New South Wales Canberra)

Wed 9 December 202015:20

Dr Timothy McLennan-Smith

We consider a red-versus-blue coupled synchronisation and spatial swarming (i.e., swarmalator) model that incorporates attraction and repulsion terms and an adversarial game of phases. The model exhibits behaviours such as spontaneous emergence of tactical manoeuvres of envelopment (e.g., flanking, pincer, and envelopment) that are often proposed in military theory or observed in nature. We classify these states based on a large set of features such as spatial densities, synchronisation between clusters, and measures of cluster distances. These features are used to study the influence of coupling parameters on the expected presence of these states and the - sometimes sharp - transitions between them.

3.14. Writing a report for the mayor: encouraging mathematics students to see the value in written communication

Mark Nelson (University of Wollongong)

Fri 11 December 202016:00

Assoc Prof Mark Nelson

> *A disease, the dynamics of which are governed by a SIR model, is spreading through a small town (population 3000). Presently 10% of the individuals in the town are infected.*
>
> *The mayor proposes to eliminate the disease by locking down all households, so as to reduce the value of the infectious contact rate to zero. The streets will be patrolled by the police and citizens will only be allowed to leave their homes for medical emergencies.*
>
> *As it is known that, on average, it takes fourteen days for an individual to recovery from the disease the major proposes to implement this measure for three weeks, "just to make sure". The mayor believes that his plan must lead to the eradication of the disease since the lockdown will ensure that there will no contacts.*
>
> *As you are the only member of this community to have studied advanced mathematics the mayor asks you for your opinion of their plan.*

In the past my mathematics students have frequently complained at any suggestion that they should communicate ideas through the medium of a written report. I discusses student responses when they were asked to write a short report for the mayor of a (hypothetical) small town in response to the mayor's plan to eliminate a contagious disease by locking it down for three weeks. What was good? What was bad? And how could the learning experience be improved?

3.15. Potential benefit of wetlands in protecting the Great Barrier Reef from excess nutrient and sediment loads

Melanie Roberts (Australian Rivers Institute, Griffith University)

Tue 8 December 202014:50

Melanie Roberts, Fernanda Adame, Jing Lu, David Hamilton

Excess nitrogen transported to the Great Barrier Reef (GBR) contributes to poor water quality, reducing the resilience of the GBR and slowing recovery. In this study we demonstrate the potential for wetlands to remove nitrogen from flood waters, contributing to efforts to meet water quality targets in the GBR through improved catchment management. We modelled the biogeochemical processes affecting nitrogen transformations (nitrification, denitrification, plant uptake, sedimentation, anammox, and mineralization) for a selected wetland case study in the Tully-Murray catchment. Our study shows that the inundation of large areas of natural wetlands could potentially remove 70

3.16. Performance analysis of work stealing in large scale multithreaded computing

Nikki Sonenberg (The Alan Turing Institute)

Fri 11 December 202015:00

Nikki Sonenberg, Grzegorz Kielanski, Benny Van Houdt

In this talk I will consider the problem of balancing workloads over a system of homogeneous processors where jobs arriving to a processor can spawn child jobs that can feasibly be executed in parallel with the parent job. We define a mean field model to derive the response time distribution in a large scale system with Poisson arrivals and exponential parent and child job durations. We consider two work stealing strategies: one where only child jobs can be transferred across servers; the other where parent jobs are transferred. Using matrix analytic methods we analyse the system and then illustrate the effect of different probe rates and load on performance.

3.17. New Functional Lennard-Jones Parameters for Heterogeneous Molecules

Kyle Jacob Stevens (The University of Newcastle)

Tue 8 December 202016:20

Mr Kyle Jacob Stevens

The continuum approach with the Lennard-Jones potential has been used successfully in modelling the interaction of various nanostructures, especially homogenoeus molecules, such as nanotubes or fullerenes. When using this approach for heterogeneous molecules, modifications have been proposed, including a semi-continuous approach that uses multiple surfaces and a fully continuous approach that assumes all atoms are homogeneously distributed over the surface of the molecule. In this talk I will present another approach that accounts for the heterogeneity of atoms within a molecule while still using a fully continuous single surface assumption. This is done by replacing the Lennard-Jones potential constants with interaction functions. I will also demonstrate an application of this approach by modelling the interaction of a carbon nanotube with a coronene molecule.

3.18. A two-dimensional asymptotic model for capillary collapse

Yvonne Stokes (The University of Adelaide)

Thu 10 December 202016:00

Prof Yvonne Stokes

The collapse under surface tension of a long axisymmetric capillary, held at both ends and softened by a travelling heater, is used to determine the viscosity *or* surface tension of silica glasses. Capillary collapse is also used in the manufacture of some optical-fibre preforms. Typically, a one-dimensional model of the closure of a concentric fluid annulus is used to relate a measure of the change in the cross-sectional geometry, for example the external radius, to the desired information. We here show that a 2D asymptotic model developed for drawing of optical fibres, but with a unit draw ratio, may be used and yields analytic formulae involving a single dimensionless parameter, the scaled heater speed V, equivalently a capillary number. For a capillary fixed at both ends, this 2D model agrees with the 1D model and offers the significant benefit that it enables determination of both the surface tension *and* viscosity from a single capillary-collapse experiment, provided the pulling tension in the capillary during collapse is measured. The 2D model also enables our investigation of the situation where both ends of the capillary are not fixed, so that the capillary cannot sustain a pulling tension. Then the collapse of the capillary is markedly different from that predicted by the 1D model and the ability to determine both surface tension and viscosity is lost.

3.19. Conformation of Graphene Wrinkles Formed on a Shrinking Solid Metal Substrate

Natalie Thamwattana (The University of Newcastle)

Fri 11 December 202010:00

Prof Natalie Thamwattana

Chemical vapour deposition (CVD) is a commonly used technique for producing high-quality graphene sheets on a substrate. However, the cooling process causes the graphene sheet to undergo a strain-induced, out-of-plane buckling resulting in graphene wrinkles. These wrinkles often lead to undesirable effects on the properties of the graphene sheet. In this talk, we construct a mathematical model to predict the conformations of these wrinkles. Initially an arch-shaped wrinkle is modelled. This is then generalised to incorporate graphene self-adhesion through van der Waals interactions across the wrinkle sides. Calculus of variations is used to determine the lowest-energy conformation for both models. We find these models predict lowest-energy wrinkle structures similar to those seen in experiments.

3.20. Travelling wave solutions in a reaction-diffusion model with nonlinear forward-backward-forward diffusion

Petrus van Heijster (Wageningen University and Research)

Thu 10 December 202015:30

Prof Petrus van Heijster

Reaction-diffusion equations (RDEs) are often derived as continuum limits of lattice-based discrete models. Recently, a discrete model which allows the rates of movement, proliferation and death to depend upon whether the agents are isolated has been proposed, and this approach gives various RDEs where the diffusion term is convex and can become negative (Johnston et al., Sci. Rep. 7, 2017). Numerical simulations suggest these RDEs, under certain choices of the system parameters, support smooth and shock-fronted travelling waves. In this talk, I will formalise these preliminary numerical observations by analysing these two types of travelling wave solutions through a dynamical systems approach.

This is joint work with Y. Li (Queensland University of Technology), M.J. Simpson (Queensland University of Technology), R. Marangell (University of Sydney) and M. Wechselberger (University of Sydney)

3.21. Application of a delayed logistic equation to a reindeer population in a closed environment

Simon Watt (UNSW Canberra)

Wed 9 December 202013:50

Rashed Saifuddin, Simon Watt, Zlatko Jovanoski

We consider a population of reindeer, which were introduced to the Pribilov Islands (Alaska) in 1911. This was seen as an outdoor laboratory, with the population observed for forty years. As there was little hunting pressure on the herd and no natural predators, the island is considered a closed system. In this talk, we present several population models of varying complexity and seek to estimate the model parameters, such as the intrinsic growth rate and carrying-capacity. Using optimisation methods, parameter estimates are found that best fit the observed population data. Finally, we quantify these models using various metrics.

3.22. Study of a location routing problem for joint delivery networks

Lele (Joyce) Zhang (The University of Melbourne)

Fri 11 December 202011:00

Dr Lele (Joyce) Zhang

Current courier networks in metropolitan areas are characterised by utilising fleets of vans that perform collection and distribution routes independently. This results in long stem distances, low load factors and high environmental costs. Joint delivery systems have the potential to reduce the distances of pick-up and drop-off routes. In this context, parcel lockers can be utilised to transfer goods between vans, electrical vehicles and bikes to improve the efficiency and sustainability of courier networks. This paper presents a model for designing joint delivery networks in urban areas by utilising parcel lockers. This model has a two-level structure: the lower level dealing with multi-depot capacitated vehicle routing problems (MDCVRP) for a set of depots and lockers whilst the upper level being a (minimum-cost) parcel network flow problem (PNFP) considering goods delivered between depots and lockers and the selection of lockers' positions and sizes. A hybrid algorithm integrating a Genetic Algorithm with the Lin-Kernighan Heuristic has been developed. The GA focuses on finding solutions for the PNFP. Once the paths of parcel flow are determined, the LKH optimises the vehicle flow. This paper is the first to consider the use of parcel lockers for business-to-business networks in the form of MDCVRP.

4. Category Theory, Algebraic Topology and K-Theory

4.1. An Operadic "Unitarization Trick"

Olivia Borghi (The University of Melbourne)

Thu 10 December 202013:00

Ms Olivia Borghi

In his 1990 paper "Quasi Hopf Algebras" Drinfeld supplies the reader with a method of producing a coboundary quasi-Hopf algebra from a quasitriangular quasi-Hopf quantized enveloping algebra. This has been affectionately coined the "unitarization trick." The category of modules over a quasitriangular quasi-Hopf algebra is braided monoidal. The category of modules over a coboundary quasi-Hopf algebra is coboundary, or cactus, monoidal. We build an operadic analog by first noticing that a category is braided monoidal if and only if it is an algebra over the parenthesized braid operad PaB and, similarly, a category is cactus monoidal if and only if it is an algebra over the parenthesized cactus operad PaC. I've shown that a specific map of the Malcev completed cactus and braid groups:

$$\Xi_n : \widehat{Cac_n} \to \widehat{Brd_n}$$

succesfully defines a map of operads in completed groupoids:

$$\xi : \widehat{PaC} \to \widehat{PaB}$$

which I call the operadic "unitarization trick."

4.2. The model category of algebraically cofibrant 2-categories

Alexander Campbell (Macquarie University)
Fri 11 December 202012:30
Dr Alexander Campbell

A basic obstruction to the development of a purely **Gray**-enriched model for three-dimensional category theory is the fact that not every 2-category is cofibrant in Lack's model structure on **2-Cat**. This obstruction can be overcome by the introduction of a new base for enrichment: the monoidal model category $\mathbf{2\text{-}Cat}_Q$ of *algebraically cofibrant 2-categories*, which is the subject of this talk.

This category $\mathbf{2\text{-}Cat}_Q$ can be defined as the category of coalgebras for the normal pseudofunctor classifier comonad on **2-Cat**, and is thus a non-full replete subcategory of **2-Cat** whose objects are the cofibrant 2-categories. (It can also be defined as the evident 2-categorical analogue of the category of simplicial computads studied by Riehl and Verity.) I will show that the category $\mathbf{2\text{-}Cat}_Q$ admits an "injective" model structure, left-induced from (and Quillen equivalent to) Lack's model structure on **2-Cat** along the left-adjoint inclusion $\mathbf{2\text{-}Cat}_Q \longrightarrow \mathbf{2\text{-}Cat}$.

Remarkably, the category of bicategories and normal pseudofunctors is equivalent, via the normal strictification functor, to the full subcategory of $\mathbf{2\text{-}Cat}_Q$ consisting of the fibrant objects for the induced model structure. Moreover, like Lack's model structure on **2-Cat**, the induced model structure on $\mathbf{2\text{-}Cat}_Q$ is monoidal with respect to the symmetric Gray tensor product, but unlike Lack's model structure, the induced model structure is also cartesian.

4.3. Generalising fibrations via multi-valued functions

Bryce Clarke (Macquarie University)
Wed 9 December 202013:20
Bryce Clarke

Possibly the most familiar category among mathematicians is the category **Set** of sets and functions. The Grothendieck construction allows us to take functors from a small category **B** into **Set** and understand them instead as special kinds of functors into **B** called discrete opfibrations. Similarly, the category **Cat** of small categories and functors plays a central role in category theory, and applying the Grothendieck construction to functors into **Cat** yields split opfibrations. Both discrete opfibrations and split opfibrations have associated lifting properties, however for certain applications in computer science a more general notion called a *lens* is required, given by a functor with specified lifts which need not be opcartesian.

A natural question to ask arises: is there a category **C** such that functors into **C** correspond to lenses under the Grothendieck construction? In this talk, I will show this question, with some minor modifications, has a simple answer by taking $\mathbf{C} = \mathbf{Mult}$, the category of sets and multi-valued functions. The talk assumes only a basic knowledge of categories and functors, and aims to build up to the main result from an understanding of sets and functions.

In technical terms, the main result proves an equivalence between lenses into **B** and lax double functors from a small category **B** into the double category of sets, functions, and (split) multi-valued functions. This provides both a new perspective on the classical notion of opfibration as well as a useful foundation for future applications of lenses in computer science.

4.4. A universal characterisation of self-homeomomorphisms of Cantor space

Richard Garner (Macquarie University)
Thu 10 December 202014:30
Dr Richard Garner

Cantor space C can be characterised universally as a terminal object among spaces X endowed with a map $X \to X + X$. The purpose of this talk is to give a similar characterisation of the set $\mathrm{Hom}(C, C)$ of continuous self-homeomorphisms of C. Recall that a *magma* is a set X endowed with a binary operation $*\colon X \times X \to X$, satisfying no further axioms. We show that $\mathrm{Hom}(C, C)$ is a terminal object among magmas X endowed with a magma map $X \to X + X$.

4.5. Higher properads

Philip Hackney (University of Louisiana at Lafayette)

Fri 11 December 202010:00

Dr Philip Hackney

Properads are gadgets akin to operads and PROPs. On the one hand, they are more expressive than operads in that they allow modeling of bialgebras. On the other, they are less expressive than PROPs, since PROPs are capable of handling algebraic structures featuring 'disconnected relations,' like Hopf algebras. Properads were introduced in Bruno Vallette's thesis in the context of Koszul duality theory, and independently in Ross Duncan's thesis in the context of quantum computation.

In this talk, we will discuss the corresponding homotopy coherent notion, that of infinity properads. This shift in perspective is analogous to the passage from ordinary categories to $(\infty, 1)$-categories, or from multicategories to infinity operads. We will give a concrete model for infinity properads, indicate methods for enrichment in monoidal categories, and discuss an issue with rectification. This talk is based on joint work with Hongyi Chu, and with Marcy Robertson and Donald Yau.

4.6. Stone-type dualities from categorical first principles

Eli Hazel (Macquarie University)

Wed 9 December 202014:50

Mx Eli Hazel

The ultrafilter monad is induced by a contravariant adjunction between the categories of Boolean algebras and sets. In the late 1960s, Manes proved that the algebras for the ultrafilter monad are precisely compact Hausdorff spaces, thereby showing them to be algebras in the universal algebraic sense; albeit with operations of infinite arity. In this talk, we show that Dubuc's adjoint triangle theorem may be used to construct a left adjoint to the induced comparison functor from Boolean algebras to compact Hausdorff spaces. Restricting this adjunction in a canonical way allows us to obtain classical Stone duality. We use the prime filter monad to obtain Priestley duality in the same way as for Stone duality. This approach is more elementary than the typical modern formulations of Stone duality and Priestley duality. Moreover, it provides a general schema for duality theorems. We will discuss current work in this vein involving an adjunction between a category of polynomial functors and the category of sets.

4.7. Accessible infinity-cosmoi

Stephen Lack (Macquarie University)

Wed 9 December 202012:50

Prof Stephen Lack

Whereas the ordinary sets, groups, rings, and spaces of mathematical practice are all small, many categories of interest are not small. In particular a category which is either complete or cocomplete can only be small if it is equivalent to a poset. *Accessible categories* are categories which are generated, in a precise sense, by small categories, and are often better behaved than other large categories. Among other things, accessibility of the categories involved facilitates the application of adjoint functor theorems.

Riehl and Verity have developed a substantial body of theory around their notion of ∞-cosmos: this is a certain categorical structure whose objects can be thought of formally as ∞-categories (categories which have not just objects and morphisms, but morphisms between morphisms, and so on). The theory is heavily homotopical in flavour.

In this talk, based on work in progress with John Bourke, I'll introduce a notion of accessibility for ∞-cosmoi. This in turn can be used to prove (homotopical) adjoint functor theorems.

4.8. Towards a 'Practical Type Theory for Symmetric Monoidal Bicategories'

Paul Lessard (Macquarie University)

Thu 10 December 202014:00

Dr Paul Paul Lessard

TO BE AMMENDED

In 'A Practical Type Theory for Symmetric Monoidal Categories' Shulman elaborates a type theory for symmetric monoidal caetgories. I will describe work towards a 2-categorical variant of that type theory.

Important type theory where generic terms are 'not-necessarily decomposeable tuples', as opposed to cartesian type theories where terms are 'decomposeable tuples'
(j.w.w. N.Dicaire, Z.Galal, P.North, M.Shulman, and S.Speight)

4.9. The Gray tensor product for 2-quasi-categories

Yuki Maehara (Macquarie University)
Fri 11 December 202012:00
Yuki Maehara

The (lax) Gray tensor product forms part of a biclosed monoidal structure on the category 2-Cat. This structure plays a crucial role in Street's formal theory of monads among other things.
In this talk, I will present a "homotopified" version of this biclosed monoidal structure using the model of 2-quasi-categories.

4.10. Decalage comonad and their restrictions

Adrian Miranda (Macquarie University)
Thu 10 December 202013:30
Mr Adrian Miranda

I will begin by reminding everyone of the Decalage construction on simplicial sets, and describe how it inherits a comonad structure from the 'free monoid'. I will then describe its category of coalgebras in a few different ways, and consider its restrictions to two distinguished subcategories of sSet which will be of interest: categories and functors, and 2-categories and normal lax functors.

4.11. An operadic perspective on compact closed categories

Sophie Raynor (Macquarie University)
Fri 11 December 202011:00
Dr Sophie Raynor

Compact closed categories are categories in which every object has a strict dual. For example, for any commutative ring R, the category of finitely generated projective R-modules and module homomorphisms is compact closed. I'll explain how there is a sense in which duality means we can forget about the direction of morphisms, and how we can use modular operads to make this idea more precise.

4.12. How to be concrete when you don't have a choice

David Roberts (The University of Adelaide)
Wed 9 December 202015:20
Dr David Roberts

There are two classical theorems on concrete categories, one more famous, one apparently no so much. The first is Freyd's theorem characterising concrete categories via a condition of Isbell, the other is due to Kučera and states that every locally small category D is a quotient of a concrete category by a congruence. In particular, there is a concrete category C with the same objects as D, and the morphisms of D are equivalence classes of morphisms of C, much as in the case of the famously non-concrete homotopy category of spaces. Both existing proofs of these theorems rely on the global axiom of choice (in the sense of: every class can be well-ordered) and are done in von Neumann–Bernays–Gödel class-set theory. I will describe how one can remove the axiom of choice altogether and even the reliance on material foundations.
Joint work with Martti Karvonen.

4.13. Quasi modular operads

Michelle Strumila (The University of Melbourne)
Wed 9 December 202015:50
Ms Michelle Strumila

Dendroidal sets are a useful tool for modelling higher operads. So too are graphical sets useful for studying higher modular operads. They form a base upon which to add the graphical inner Kan condition, and thus through a nerve theorem can model strict modular operads too. I have established this theory of quasi modular operads, as well as an example from topology and inspired by TQFTs.

4.14. Dualities for accessible categories

Giacomo Tendas (Macquarie University)

Wed 9 December 202013:50
Mr Giacomo Tendas

A small category with finite limits can bee seen as a *theory*, whose models are the finite-limit-preserving functors into Set. These contain, but are more general than algebraic theories or even the Horn theories of universal algebra. Gabriel-Ulmer characterized the categories of models of these theories and called them locally finitely presentable categories. This leads to a duality between finite limit theories, on the one hand, and locally finitely presentable categories on the other.

There are various other such dualities, each induced by homming into Set, between theories of some type and their categories of models. For example, Diers showed a duality between the 2-category of locally finitely multipresentable categories and that of small finitely multicomplete categories. It is known that locally finitely presentable and multipresentable categories can be described equivalently as those finitely accessible categories which admit all limits and all connected limits respectively. The aim of this talk is then to recover these dualities as instances of one involving on one side the 2-category of finitely accessible category with Ψ-limits, and on the other that of finitely complete categories which arise as free completions under $\mathcal{D}$-colimits. Here Ψ and $\mathcal{D}$ are classes of indexing diagrams which satisfy some commutativity and completeness conditions in Set. We will then see how to recover Gabriel-Ulmer and Diers duality from this generalization, and show other examples of such classes Ψ and $\mathcal{D}$.

5. Combinatorics and Graph Theory

5.1. Walks obeying two-step rules on the square lattice

Nicholas Beaton (The University of Melbourne)

Thu 10 December 202015:30
Dr Nicholas Beaton

We consider walks on the edges of the square lattice $\mathbb{Z}^2$ which obey two-step rules, which allow (or forbid) steps in a given direction to be followed by steps in another direction. We classify these rules according to a number of criteria, and show how these properties affect their generating functions, asymptotic enumerations and limiting shapes, on the full lattice as well as the half and quarter planes.

5.2. Geometry of Mutually Unbiased Bases in Dimension 6

James Bubear (RMIT University)

Thu 10 December 202013:30
Mr James Bubear

Walks in the complex plane constructed from the vector dot product of mutually unbiased bases are examined. We focus on mutually unbiased bases that are equivalent to Butson-Hadamard matrices, whose walks are on the lattice generated by complex roots of unity.

Next generation quantum safe encryption may rely on mutually unbiased bases, there are many open problems. Consider the dot product of two mutually unbiased vectors in $\mathbb{C}^d$ as a walk with unit steps in the complex plane ending on a lattice point of magnitude $\sqrt{d}$. We show that for dimension 6 on the lattice generated by the 6^{th} roots of unity, there are no walks that end on a lattice point of magnitude $\sqrt{6}$. Therefore there are no pair of Butson-Hadamard matrices $BH(6,6)$ that are unbiased.

5.3. Group divisible designs of block size 4 with group sizes 3 and 6

Yudhistira Andersen Bunjamin (UNSW Sydney)

Thu 10 December 202013:00
R. Julian R. Abel, Yudhistira A. Bunjamin, Diana Combe

A k-GDD, or *group divisible design* with block size k, is a triple $(X, \mathcal{G}, \mathcal{B})$ where X is a set of *points*, $\mathcal{G}$ is a partition of X into subsets (called *groups*) and $\mathcal{B}$ is a collection of k-element subsets of X (called *blocks*) such that any two points from distinct groups appear together in exactly one block and no two distinct points from any group appear together in any block. The *group type* (or *type*) of a k-GDD is the multiset $\{|G| : G \in \mathcal{G}\}$ which denotes the group sizes.

There are a number of known necessary conditions for the existence of a GDD with a particular group type which come from simple counting arguments. However, these conditions are not sufficient. A group type for a k-GDD is said to be *feasible* if it satisfies all of the currently known necessary conditions for its existence.

Although 3-GDDs are relatively well-studied, little is known about 4-GDDs. This talk will focus on 4-GDDs which have only groups of size 3 and 6, denoted as 4-GDDs of type 3^t6^s. We will introduce the two most common techniques for constructing GDDs and show how they can be used to construct a 4-GDD for all but a finite number of feasible type 3^t6^s.

Joint work with Julian Abel and Diana Combe.

5.4. An Evans-style result for block designs

Ajani De Vas Gunasekara (Monash University)

Tue 8 December 202015:20

Ajani De Vas Gunasekara, Daniel Horsley

For positive integers n and k with $n \geq k$, an $(n, k, 1)$-*design* is a pair $(V, \mathcal{B})$ where V is a set of n *points* and $\mathcal{B}$ is a collection of k-subsets of V called *blocks* such that each pair of points occur together in exactly one block. If we weaken this condition to demand only that each pair of points occur together in at most one block, then the resulting object is a *partial* $(n, k, 1)$-*design*. A *completion* of a partial $(n, k, 1)$-design $(V, \mathcal{A})$ is a (complete) $(n, k, 1)$-design $(V, \mathcal{B})$ such that $\mathcal{A} \subseteq \mathcal{B}$. In this talk, I will determine exactly the minimum number of blocks in an uncompletable partial $(n, k, 1)$-design for sufficiently large n. This result is reminiscent of Evans' now-proved conjecture on completions of partial latin squares.

5.5. Mixing time of the switch Markov chain and stable degree sequences

Catherine Greenhill (University of New South Wales)

Tue 8 December 202016:20

Prof Catherine Greenhill

The switch chain is a well-studied Markov chain which can be used to sample from the set of all graphs with a given degree sequence. Polynomial mixing time has been established for the switch chains under various conditions on the degree sequences, related to notions of stability for degree sequences. I will discuss some work on this topic.

5.6. Fraisse limits of Steiner triple systems

Daniel Horsley (Monash University)

Thu 10 December 202016:00

Dr Daniel Horsley

A mathematical object is *homogeneous* if every isomorphism between two of its subobjects can be extended to an automorphism of the whole object. Fraïssé's theorem allows one to take a countably infinite class of finite objects that obeys certain properties (an *amalgamation class*) and obtain its *Fraïssé limit*: a homogeneous countably infinite object whose finitely generated subobjects are exactly the elements of the amalgamation class. For example, the Fraïssé limit of the class of all graphs is the well-known Rado graph. In this talk I will discuss some recent work with Bridget Webb in which we show that classes of Steiner triple systems avoiding specified subsystems are amalgamation classes. Taking Fraïssé limits of these classes produces homogeneous countably infinite Steiner triple systems that are somewhat analogous to the Henson graphs. Unlike in the case of graphs however, we do not have a complete classification of the homogeneous countably infinite Steiner triple systems.

5.7. Matchings in graphs from spectral radius

Suil O (SUNY Korea)

Tue 8 December 202014:50

Dr Suil O

A matching in a graph G is a set of disjoint edges; the matching number of G is the maximum size of a matching in it. In this talk, we prove the best lower bound for the spectral radius in an n-vertex connected graph G to guarantee a certain matching number.

5.8. Harary Polynomials

Vsevolod Rakita (Technion, Israel Institute of Technology)

Tue 8 December 202015:50

Mr Vsevolod Rakita

Given a graph property $\mathcal{P}$, F. Harary introduced in 1985 $\mathcal{P}$-colourings, graph colourings where each colour class induces a graph in $\mathcal{P}$. Let $\chi_{\mathcal{P}}(G;k)$ count the number of $\mathcal{P}$-colourings of G with at most k colours. Then $\chi_{\mathcal{P}}(G;k)$ is a polynomial in k for all graphs G. Graph polynomials of this form are called Harary Polynomials.

We investigate the properties of Harary polynomials and compare them with properties of the classical Chromatic Polynomial $\chi(G;k)$ We show that the characteristic, Laplacian, matching, independence and domination polynomials are not Harary polynomials. We show that for various notions of sparse, non-trivial properties $\mathcal{P}$, the polynomial $\chi_{\mathcal{P}}(G;k)$ is, unlike the chromatic polynomial, not a deletion-contraction invariant, and not even an edge elimination invariant. Finally, we study whether Harary polynomials are definable in Monadic Second Order Logic. Joint work with O. Herscovici and J.A. Makowsky

5.9. Using marginal analysis to analyse the discrete Kruskal-Katona function and antichains, and some related functions defined on ordered collections of sets.

Ian Roberts (Charles Darwin University)

Thu 10 December 202014:00

Dr Ian Roberts

Consider a well-defined discrete set of functions whose graphs 'look fractal', and converge uniformly to a nowhere differentiable continuous function (the Takagi function, 1903). How does one analyse such sets of functions?

We will mainly consider the Kruskal-Katona function (KK-function) which Frankl et.al. considered in detail (1995). They explicitly noted the problems with the traditional methods of analysis of the KK-function. This includes the difficulty of using embedded sums of binomial coefficients in the standard analysis.

We introduce a new way to consider such functions, with the domains consisting of collections of sets in some order. The key aspect involves partitioning each function to provide a micro-view of it through a small number of similar components, and with each of the similar components repeated in a well-defined manner. There is a geometric model involving simple integer sequences, an associated notion of the dimension of the geometric space, and the concept of marginal analysis and 'discrete calculus'. This provides new insights, and can ameliorate the difficulties in analysis that arise with embedded binomial sums.

There are many small aspects needed to tell the story, so the talk will have a strong visual element to provide the flavour of the problems and their solutions.

Definitions: An *antichain* is a collection $\mathcal{A}$ of subsets of $[n] = \{1, 2, ..., n\}$ such that no set in $\mathcal{A}$ is a subset of another set in $\mathcal{A}$. Two sets $A, B \in \mathcal{A}$ are in *squashed order*, written $A \leq_s B$, if the largest element of the symmetric difference $(A \setminus B) \cup (B \setminus A)$ is in B. The *shadow* of a collection of k-sets $\mathcal{A}_k$ is $\Delta(\mathcal{A}_k) = \{B : |B| = k-1,\, B \subset A, \text{ for some } A \in \mathcal{A}_k\}$.

For non-negative integers $k, n,\ k \leq n$, the *KK-function* is defined on the choices of collections of the first k-sets on $[n]$ in squashed order: $K(\mathcal{A}_k) = |\Delta(\mathcal{A}_k)| - |\mathcal{A}_k|$ for $|\mathcal{A}_k| \in \{0\} \cup [\binom{n}{k}]$.

5.10. Stack-number is not bounded by queue-number

David Wood (Monash University)

Thu 10 December 202015:00

Prof David Wood

Stacks and queues are fundamental data structures in computer science. But which is more powerful, stacks or queues? In 1992, Heath, Leighton and Rosenberg introduced an approach for answering this question by defining the graph parameters stack-number and queue-number, which respectively measure the power of stacks and queues for representing graphs. Despite numerous papers on the topic, the following fundamental questions have remained unsolved:

- Is stack-number bounded by a function of queue-number?
- Is queue-number bounded by a function of stack-number?

In this talk I will describe a family of graphs with queue-number at most 4 but unbounded stack-number, thus resolving the first question in the negative. Intuitively speaking, this says that stacks are not more powerful than queues. As a corollary, we resolve an open problem of Blankenship and Oporowski (1999). This is joint work with Vida Dujmović, David Eppstein, Robert Hickingbotham and Pat Morin (arXiv:2011.04195).

6. Computational Mathematics

6.1. The Impact of Grid Velocity Resolution on the Detection of Lagrangian Coherent Structures

Aleksandar Badza (The University of Adelaide)

Wed 9 December 202014:20

Mr Aleksandar Badza

Lagrangian coherent structures are objects such as curves or surfaces which give a general illustration of the most chaotic and the most robust flow patterns observable within a fluid subject to an unsteady velocity field over a specified time interval. These structures are detected using a wide variety of methods with each of these susceptible to a range of different computational limitations, including the grid resolution of velocity data. In this talk, we will look at the functionality of six of these methods, namely the finite time Lyapunov exponent, hyperbolic variational structures, Lagrangian averaged vorticity deviation, stochastic sensitivity, transfer operator and coherent structure colouring; in detecting Lagrangian coherent structures within a rapidly evolving Kelvin-Helmholtz flow.

6.2. Numerical solution of a two dimensional tumour growth model with moving boundary

Gopikrishnan Chirappurathu Remesan (Monash University)

Wed 9 December 202015:50

Mr Gopikrishnan Chirappurathu Remesan

We consider a biphasic continuum model for avascular tumour growth in two spatial dimensions, in which a cell phase and a fluid phase follow conservation of mass and momentum. A limiting nutrient that follows a diffusion process controls the birth and death rate of the tumour cells. The cell volume fraction, cell velocity–fluid pressure system, and nutrient concentration are the model variables. A coupled system of a hyperbolic conservation law, *a viscous fluid model*, and a parabolic diffusion equation governs the dynamics of the model variables. The tumour boundary moves with the normal velocity of the outermost layer of cells, and this time–dependence is a challenge in designing and implementing a stable and fast numerical scheme. We recast the model into a form where the hyperbolic equation is defined on a fixed extended domain and retrieve the tumour boundary as the interface at which the cell volume fraction decreases below a threshold value. This procedure eliminates the need to track the tumour boundary explicitly and the computationally expensive re–meshing of the time–dependent domains. A numerical scheme based on finite volume methods for the hyperbolic conservation law, Lagrange $\mathbb{P}_2 - \mathbb{P}_1$ Taylor–Hood finite element method for the *viscous* system, and mass–lumped finite element method for the parabolic equations is implemented in two spatial dimensions, and several cases are studied. We demonstrate the versatility of the numerical scheme in catering for irregular and asymmetric initial tumour geometries. When the nutrient diffusion equation is defined only in the tumour region, the model depicts growth in free suspension. On the contrary, when the nutrient diffusion equation is defined in a larger fixed domain, the model depicts tumour growth in a polymeric gel. We present numerical simulations for both cases and the results are consistent with theoretical and heuristic expectations such as early linear growth rate and preservation of radial symmetry when the boundary conditions are symmetric. The work presented here could be extended to include the effect of drug treatment of growing tumours.

6.3. Diagonalising Infinite-Dimensional Operators: Computing spectral measures of self-adjoint operators

Matthew Colbrook (University of Cambridge)

Thu 10 December 202016:30

Dr Matthew Colbrook

Spectral measures of self-adjoint operators arise in numerous applications, providing an analogue of diagonalisation through the spectral theorem. Using the resolvent operator (solving shifted linear systems), we develop an algorithm for computing smoothed approximations of spectral measures associated with self-adjoint operators. The algorithm can achieve arbitrarily high orders of convergence in terms of a smoothing parameter for computing spectral measures of general differential, integral, and lattice operators. Explicit pointwise and L^p-error bounds are derived in terms of the local regularity of the measure. We provide numerical examples (using state-of-the-art spectral methods), including PDEs, a magnetic tight-binding model of graphene, and compute 1000 eigenvalues of a Dirac operator to near machine precision without spectral pollution. The algorithm is publicly available in `SpecSolve`, which is a software package written in MATLAB. This is joint work with Andrew Horning and Alex Townsend.

6.4. Numerical analysis of two-phase flows models with mechanical deformation in fracture porous media

Jerome Droniou (Monash University)

Thu 10 December 202013:00
Prof Jerome Droniou

Flows in porous media, e.g. as in reservoir engineering (oil recovery, carbon storage, etc.), can be extremely complex, involving multiple species in multiple phases and complex features in domain geometry. Numerical simulation is the only reasonable approach, in practice, to obtain qualitative and quantitative information on these flows.

In this talk, we will consider a flow model involving two phases and fracture medium, with possible mechanical deformation of the medium. The model comprises transport equations in the main matrix (typically, 3D domain), coupled with equations in the fractures (represented as a 2D domain), together with linear elasticity equation modelling the fracture deformation. We propose a numerical approximation of this model, based on the Gradient Discretisation Method (which covers many possible numerical methods, such as finite elements, finite volumes, etc.). We will present an overview of the convergence analysis, based on compactness arguments and discrete functional analysis, as well as a set of numerical results.

6.5. On the stability of the PML for propagating waves in SBP and DG methods

Kenneth Duru (The Australian National University)

Thu 10 December 202014:30
Dr Kenneth Duru

It is well-known that accurate and efficient domain truncation is crucial to the accurate numerical solution of most wave propagation problems. The perfectly matched layer (PML) is a method which, when stable, can provide a domain truncation which is convergent with increasing layer width/damping. The difficulties in using PML are primarily associated with stability. The layer equations are not symmetric (or apparently symmetrisable in real space), which means that standard Galerkin-based stability or standard energy analyses cannot be applied. In particular, equations for auxiliary PML variables include derivatives of the physical fields. In this presentation we will discuss Laplace-transform-based stability analyses which establishes the stability of SBP and DG discretisations of a standard complex stretching PML formulation for linear waves. Our approach is rooted in a rigorous mathematical analysis, beginning from the continuous model down to the discrete problem. We derive continuous energy estimates for the PML in the Laplace space. By emulating the energy estimate in the discrete setting we construct asymptotically stable DG approximation of the PML for the wave equation. The analysis will focus on the 3D linear acoustics wave equation. But we will demonstrate extensions of our method to the 3D linear elasto-dynamic equations. These have been implemented in WaveQLab a petascale SBP finite difference code and in the DG code, ExaHyPE, a simulation engine for hyperbolic PDEs on adaptive Cartesian meshes, for exascale supercomputers.

6.6. Stochastic Landau-Lifshitz equation on real line

Farah El Rafei (UNSW Sydney)

Wed 9 December 202015:20
Mrs Farah El Rafei

In this talk, I present my research on the Stochastic Landau-Lifshitz equation where I suggest a method to numerically solve the Stochastic Landau-Lifshitz problem on real line with homogeneous Neumann boundary conditions at infinity. In fact, for simulations, a truncation of the infinite domain is necessary. Therefore, I consider the Stochastic Landau-Lifshitz problem on a bounded domain $[-L, L]$ with artificial Neumann boundary conditions and prove that when the domain is large enough the solutions u_L of the problems on bounded domains converge to the solution u of the main problem on real line. Then, I present a fully discrete finite difference scheme to solve the problem on a bounded domain. Partial results have been obtained to prove convergence of the finite difference scheme. Finally, I show numerical experiments which validate the numerical method.

6.7. Approximating probabilities using preintegrated quasi-Monte Carlo methods

Alexander Gilbert (University of New South Wales)

Tue 8 December 202014:50

Dr Alexander Gilbert

Computing probabilities for high-dimensional random variables is a difficult task that arises in many applications, ranging from derivatives pricing in finance to computing failure probabilities in engineering. By formulating this probability as the expected value of an indicator function of the random variable, the problem becomes one of computing a high-dimensional integral. Quasi-Monte Carlo (QMC) methods are deterministic quadratures rules that have recently achieved great success in efficiently computing high-dimensional integrals. However, the success of QMC typically requires some level of smoothness in the integrand, which for the problem of computing a probability is destroyed by the discontinuity caused by the indicator function. Recent work on preintegration (a.k.a. conditional expectation) showed that first integrating certain discontinuous functions with respect to a single variable results in a smoother function, but now in one dimension less.

In this talk, I will present a preintegrated QMC method based on randomly shifted lattice rules for computing probabilities of a random variable defined on $\mathbb{R}^s$. The basic idea is to "integrate out" the discontinuity in one dimension, and then apply a lattice rule to the remaining $(s-1)$-dimensional function, which is now as smooth as the original random variable. A key theoretical result that is required for the error analysis is an equivalence between classical Sobolev spaces and the unanchored spaces used for the analysis of lattice rules on $\mathbb{R}^s$. Finally, to illustrate the power of this method we apply it to a problem from options pricing and present some numerical results.

6.8. Hessian recovery based finite element methods for the Cahn-Hilliard equation

Hailong Guo (The University of Melbourne)

Thu 10 December 202013:30

Dr Hailong Guo

In this talk, we will introduce several novel recovery based finite element methods for the 2D Cahn-Hilliard equation. One distinguishing feature of those methods is that we discretize the fourth-order differential operator in a standard continuous linear finite elements space. Precisely, we first transform the fourth-order Cahn-Hilliard equation to its variational formulation in which only first-order and second-order derivatives are involved and then we compute the first and second-order derivatives of a linear finite element function by a least-squares fitting recovery procedure. When the underlying mesh is uniform meshes of regular pattern, our recovery scheme for the Laplacian operator coincides with the well-known five-point stencil. Another feature of the methods is some special treatments on Neumann type boundary conditions for reducing computational cost. The optimal-order convergence and energy stability are numerically proved through a series of benchmark tests. The proposed method can be regarded as a combination of the finite difference scheme and the finite element scheme.

6.9. Vibrations of Ice Shelves

Balaje Kalyanaraman (The University of Newcastle)

Wed 9 December 202016:20

Mr Balaje Kalyanaraman

In this talk, I will present a mathematical model to study ocean wave-induced vibrations of ice shelves. The model is based on linear elasticity for the ice-shelf and potential flow for the fluid. The resulting governing equations are solved using the finite element method using a modal expansion technique by expressing the displacement field as a linear combination of the in-vacuo modes of the ice shelf. The model is validated by comparison with the thin-beam theory. Finally, I will present a few results by considering real-life shelf-cavity profiles, extracted from the BEDMAP2 dataset.

6.10. Divergence conforming discontinuous Galerkin method for Stokes eigenvalue Problems

Arbaz Khan (Indian Institute of Technology Roorkee)

Wed 9 December 202017:20

Prof Arbaz Khan, Prof Joscha Gedicke

Over the last couple of decades, eigenvalue problems in fluid mechanics are of great importance because of their role for the stability analysis of fluid flow problems. Hence, the development of numerical methods for the Stokes problem, as a model for incompressible fluid flow, is of great interest. In this talk, we discuss a divergence-conforming discontinuous Galerkin finite element method for Stokes eigenvalue problems. The first part of this talk is to discuss a priori error analysis for Stokes eigenvalue problems. The second part of this talk is to discuss a posteriori error estimation for Stokes eigenvalue problems. Finally, we present specific numerical examples to validate the theoretical results.

6.11. Ensemble transform Kalman filter parameter estimation for reduced biases in a global coupled climate model

Vassili Kitsios (CSIRO)

Thu 10 December 202015:30

Dr Vassili Kitsios, Dr Paul Sandery, Dr Terence O'Kane, Dr Russell Fiedler

General circulation models are unable to explicitly resolve all of the physical processes present in the global coupled atmosphere/ocean/sea-ice climate system. The spatial scales range from millimetres to hundreds of thousands of kilometres. One, therefore, resorts to parameterising the influence of the unresolved small scale processes onto the larger resolved ones. Many of these parameters are known with little precision, or are empirically "tuned" in an attempt to minimise model biases often at the expense of the physical realism of the parameter value. Within a data assimilation (DA) framework, we use an ensemble transform Kalman filter to systematically and objectively estimate parameters in the ocean component that minimise the difference between a 96 member ensemble of short term (days to months) climate model forecasts and a network of real-world observations of the Earth system. The DA experiments are undertaken during a period within which the ocean was well observed from 2010 to 2012. The number of model states is approximately 100 million. These learnt parameters are shown to improve the fit of the DA system to the observations, and also reduce the onset of model bias in longer multi-year forecasts of the freely running climate model during an out-of-sample period from 2012 to 2020.

6.12. A mixed finite element method for fourth and sixth-order elliptic problems

Bishnu Lamichhane (The University of Newcastle)

Fri 11 December 202010:00

Dr Bishnu Lamichhane

We present mixed finite element methods for fourth and sixth-order elliptic problems. The main idea is to be able to use the lowest order standard finite element space to approximate solutions of the higher-order problems.

6.13. Existence of martingale solution to stochastic Navier-Stokes equations on a spherical shell

Quoc Thong Le Gia (University of New South Wales)

Fri 11 December 202010:30

Dr Quoc Thong Le Gia

In this talk, we discuss the existence of martingale solution to stochastic Navier-Stokes equations on a spherical shell with multiplicative noise. Under the assumption that the multiplicative noise is Lipschitz and satisfies the linear growth condition, we show that there exists a martingale solution to the stochastic Navier-Stokes equation on a spherical shell.

This is a joint work with Zdzislaw Brzezniak (University of York, UK) and Gaurav Dhariwal (TU Vienna, Austria).

6.14. Energetically consistent upwinding for Hamiltonian systems in geophysics using mixed finite elements

David Lee (Bureau of Meteorology)

Thu 10 December 202015:00

Dr David Lee

Mimetic discretisations that preserve the skew-symmetric structure of the Hamiltonian form of the equations of motion have the potential to improve the representation of dynamical processes in atmospheric models. This is achieved by satisfying the exact balance of energetic exchanges in space and time. This talk will discuss the supression of spurious oscillations associated with nonlinear processes in an energetically consistent manner by systematically adding dissipation to other convex moments of the governing equations (potential enstrophy, entropy), while preserving the skew-symmetric structure of the discrete system that is synonymous with energetic balance. This is achieved within the context of a mixed finite element method by the upwinding of test functions in the direction of the flow field for flux form hyperbolic terms, and conversely the downwinding of trial functions for material form advection operators. Examples are given for standard test cases for both the rotating shallow water equations on the sphere, and the 3D compressible Euler equations.

6.15. On M/G/1 feedback queueing system with repeated service under N-policy and a random setup time

Snigdha Mahanta (Institute of Advanced Study in Science and Technology)

Wed 9 December 202013:50

Snigdha Mahanta (Institute of Advanced Study in Science and Technology, India)

An M/G/1 two types of general heterogeneous queueing system with general server setup time under N- policy is considered. After completion of his/her service, a customer may depart from the system for taking the service again and again till his service becomes successful. The arrival rate varies according to the server's status and a customer can repeat the same type of service. The steady-state of this system, waiting time, and expected busy period has been derived for this system. The behavior of system operational cost and optimal N are also analyzed by numerical study.

6.16. A Fractional Diffusion Model for Dye-Sensitized Solar Cells

Benjamin Maldon (The University of Newcastle)

Tue 8 December 202015:20

Mr Benjamin Maldon

Dye-Sensitized Solar Cells (DSSCs) play a vital role in renewable energy as a third-generation photovoltaic device. The efficiency and current-voltage characters of a typical DSSC are usually derived from the density of conduction band electrons within the nanoporous semiconductor of the DSSC. Given the known fractal geometry of the commonly used semiconductor Titanium Dioxide (TiO2), a natural direction for mathematically modelling DSSCs uses fractional diffusion. With a Caputo fractional time derivative we solve this fractional diffusion equation numerically to investigate the effect of the fractional derivative on the diffusion process in an operating DSSC.

6.17. Wave Interaction with Floating Elastic Plates

Michael Meylan (The University of Newcastle)

Wed 9 December 202016:50

Assoc Prof Michael Meylan

The problem of wave scattering by floating elastic plates has been very well studied because it can be used to model many different phenomena in fields ranging from geophysics to ocean engineering. I will talk here about how we can simulate the motion in the time-domain using the frequency domain solution. The talk will be illustrated with animations of the complex interactions which can easily be simulated.

6.18. Mechanical cell competition in heterogeneous epithelial tissues

Ryan Murphy (Queensland University of Technology)

Tue 8 December 202015:50

Mr Ryan Murphy

Mechanical cell competition is important during tissue development, cancer invasion, and tissue ageing. Heterogeneity plays a key role in practical applications since cancer cells can have different cell stiffness and different proliferation rates than normal cells. To study this phenomenon, we propose a one-dimensional mechanical model of heterogeneous epithelial tissue dynamics that includes cell-length-dependent proliferation and death mechanisms. Proliferation and death are incorporated into the discrete model stochastically and arise as source/sink terms in the corresponding continuum model that we derive. Using the new discrete model and continuum description, we explore several applications including the evolution of homogeneous tissues experiencing proliferation and death, and competition in a heterogeneous setting with a cancerous tissue competing for space with an adjacent normal tissue. This framework allows us to postulate new mechanisms that explain the ability of cancer cells to outcompete healthy cells through mechanical differences rather than an intrinsic proliferative advantage. We advise when the continuum model is beneficial and demonstrate why naively adding source/sink terms to a continuum model without considering the underlying discrete model may lead to incorrect results.

6.19. Nonlinear reduced modelling and state estimation of parametric PDEs

James Ashton Nichols (Australian National University)

Thu 10 December 202014:00

Dr James Ashton Nichols

We examine the problem of state estimation, that is, reconstructing the solution of a known parametric PDE from m linear measurements. When linear reduced models are used, well known results in reconstruction stability and approximation errors can be used to give bounds of overall error of state estimation. We present some new results and schemes for the deployment of nonlinear reduced models for this task, specifically models that are locally linear for disjoint partitions of the parameter domain. One challenge in this task is sensing which locally linear model to apply, given some specific measurements. Our strategy for this is to consider the residuals, and chose local linear models according to which minimizes the residual associated with the PDE. We discuss results and some interesting dual-minimization strategies for parameter estimation that arise, and present a numerical study of this strategy.

6.20. Numerical methods for stress-assisted diffusion models for biomechanics

Ricardo Ruiz Baier (Monash University)

Wed 9 December 202012:50

Assoc Prof Ricardo Ruiz Baier

In this talk we introduce a family of mathematical models for the simulation of the active contraction of cardiac tissue using stress-assisted conductivity as a mechanism for mechanoelectrical feedback. The specific structure of the governing equations (written in terms of stress, displacements, electric potential, activation generation, and ionic variables) suggests to cast the problem in mixed-primal form. We explore the properties of the model, together with the importance of coupling variables, by means of a few computational experiments. These results suggest that stress-assisted conductivity induces an additional degree of heterogeneity and anisotropy in the propagation of the transmembrane potential, it produces conduction velocity modifications and spiral wave drifting. We also state and briefly discuss a reduced model that keeps the coupling character of the original system, but that simplifies substantially the solvability and numerical analysis. It consists of linear elasticity nonlinearly coupled with scalar diffusion in the steady regime. We also address the formulation of mixed methods for formulations of hyperelasticity using the Kirchhoff stress.

6.21. Applications of rank-1 lattice rules to exact function reconstruction in the non-periodic setting

Abirami Srikumar (UNSW Sydney)

Tue 8 December 202016:20

Miss Abirami Srikumar

As high dimensional problems become increasingly prevalent in many applications, the need for effective computational methods has become an issue sparking great discussion. One class of strategies for evaluating such problems without suffering from the "curse of dimensionality" are quasi-Monte Carlo methods. In this talk, we focus on the application of QMC methods to function reconstruction and discuss the translation of exact reconstruction theory using rank-1 lattice rules from the well-understood periodic Fourier space to the non-periodic cosine and Chebyshev spaces. We also present results of numerical experiment and compare the performance of various component-by-component construction strategies used to find generating vectors that ensure exact reconstruction.

6.22. Remarks on Sobolev norms of fractional orders

Thanh Tran (University of New South Wales)

Thu 10 December 202016:00

Prof Thanh Tran

This talk aims to clarify some aspects in the theory of fractional-order Sobolev spaces, which are important in some numerical schemes for boundary value problems using boundary integral equation methods. The main issue addressed is the following. When a function belonging to a fractional-order Sobolev space is supported in a proper subset of the Lipschitz domain on which the Sobolev space is defined, how is its Sobolev norm as a function on the smaller set compared to its norm on the whole domain? Whenever this is possible, on what does the comparison constants depend? We prove some inequalities and disprove some misconceptions by counter-examples.

6.23. Hybrid High-Order methods with small faces

Liam Yemm (Monash University)

Wed 9 December 202014:50

Mr Liam Yemm

The Hybrid High-Order (HHO) method is a modern numerical scheme for solving elliptic partial differential equations. We investigate a HHO discretisation of a diffusion equation on meshes possessing numerous small faces. Such meshes are often unavoidable for physical problems posed in complex geometric domains. The method is shown to converge independent of the size of mesh faces, which is supported by numerical results.

7. Complex analysis and geometry

7.1. Polystability and the Hitchin-Kobayashi correspondence

Nicholas Buchdahl (The University of Adelaide)

Tue 8 December 202016:20

Dr Nicholas Buchdahl

The Hitchin-Kobayashi correspondence states that a holomorphic vector bundle on a compact hermitian manifold admits an irreducible Hermite-Einstein connection if and only if the bundle is stable. The "only if" part of the result was proved by Kobayashi and independently by Luebke around 1981, at least in the case of Kaehler manifolds. For such manifolds, the "if" part of the result was proved by Uhlenbeck and Yau around 1985, following on from earlier results of Donaldson in the 1- and 2-dimensional cases. Donaldson's approach in the 2-dimensional case was closely related to ideas of Atiyah and Bott, drawing on an analogy between stability for holomorphic bundles and the notion of stability in Mumford's (finite-dimensional) Geometric Invariant Theory.

In this talk, I shall present some results obtained jointly with Georg Schumacher showing that the analogy between the finite- and infinite-dimensional pictures is somewhat deeper than it appears at first sight.

7.2. Sasaki geometry and a construction of a quasi-Einstein shearfree spacetimes

Masoud Ganji (University of New England)

Thu 10 December 202014:00

Dr Masoud Ganji

In this talk we prove that a certain class of smooth Sasaki manifolds admits lifts to 4-dimensional quasi-Einstein shearfree spacetimes of Petrov type II or D. In particular, this holds for all tubular CR manifolds. Furthermore, we show that any Sasaki manifold with underlying Khler-Einstein manifold with non-zero Einstein constant has a lift to a shearfree Einsteinmetric of Petrov type II or D.

This is joint work with Gerd Schmalz and Daniel Sykes.

7.3. A conformally invariant Yang-Mills energy and equation on 6-manifolds

Rod Gover (University of Auckland)

Thu 10 December 202013:00
Prof Rod Gover

The gauge field equations known as the Yang-Mills equations are extremely important in both mathematics and physics, and their conformal invariance in dimension 4 is a critical feature for many applications. We show that there is a simple and elegant route to higher order equations in dimension 6 that are analogous and arise as the Euler-Lagrange equations of a conformally invariant action. The functional gradient of this action recovers the conformal Fefferman-Graham obstruction tensor when the gauge connection is taken to be the conformal Cartan (or tractor) connection.

This has importance for CR geometry through the the Fefferman ambient metric.

This is joint work with Larry Peterson and Callum Sleigh.

7.4. Highly symmetric homogeneous Kobayashi-hyperbolic manifolds

Elliot Herrington (The University of Adelaide)

Tue 8 December 202014:50
Mr Elliot Herrington

Kobayashi-hyperbolic manifolds are an important and well-studied class of complex manifolds defined by the property that the Kobayashi pseudodistance is in fact a true distance. Such manifolds that have automorphism group of sufficiently high dimension can be classified up to biholomorphism, and the goal of this project is to continue the classification of homogeneous Kobayashi-hyperbolic manifolds started by Alexander Isaev in the early 2000s. We proceed in this endeavour by analysing the Lie algebra of the automorphism groups that act on such manifolds. This talk will begin with a discussion of symmetry groups in modern geometry and a careful definition of a Kobayashi-hyperbolic manifold, before delving into some of the details of the project work.

7.5. Legendrian holomorphic curves in complex projective 3-space and superminimal surfaces in the 4-sphere

Finnur Larusson (The University of Adelaide)

Tue 8 December 202015:20
Prof Finnur Larusson

I will describe recent joint work with Antonio Alarcon and Franc Forstneric (to appear in Geometry and Topology). Complex projective 3-space $\mathbb{CP}^3$ carries an essentially unique complex contact structure, which is of interest for a number of reasons. We study holomorphic immersions and general holomorphic maps from Riemann surfaces to $\mathbb{CP}^3$ that are Legendrian with respect to this structure. For example, we prove approximation and interpolation theorems for such maps, and we prove that every Riemann surface admits a complete injective Legendrian holomorphic immersion into $\mathbb{CP}^3$. We use the twistor projection from $\mathbb{CP}^3$ onto the 4-sphere to derive corollaries for superminimal surfaces in the 4-sphere.

7.6. Einstein hypersurfaces of rank-one symmetric spaces

Yuri Nikolayevsky (La Trobe University)

Wed 9 December 202013:50
Dr Yuri Nikolayevsky

Rank-one symmetric spaces are ”the most symmetric” Riemannian spaces one can think of. Their classification dates back to Cartan, and at present, they are very well understood. However, much less is known about submanifolds (in particular, hypersurfaces) of such spaces. In the talk, I will first give an overview of known results, and then present the classification of Einstein hypersurfaces in the Cayley projective plane and in its noncompact dual. This result completes the classification of Einstein hypersurfaces in rank-one symmetric spaces.

This is a joint work with J.-H.Park and S.Kim (SKKU, Korea).

7.7. Conformal Killing Yano 2-forms on Lie groups

Marcos Origlia (Monash University)

Wed 9 December 202013:20

Dr Marcos Origlia

A differential p-form η on a n-dimensional Riemannian manifold (M, g) is called Conformal Killing Yano (CKY for short) if it satisfies for any vector field X the following equation

$$\nabla_X \eta = \frac{1}{p+1} \iota_X \mathrm{d}\eta - \frac{1}{n-p+1} X^* \wedge \mathrm{d}^* \eta,$$

where X^* is the dual 1-form of X, d^* is the codifferential, ∇ is the Levi-Civita connection associated to g and ι_X is the interior product with X. If η is coclosed ($\mathrm{d}^*\eta = 0$) then η is said to be a Killing-Yano p-form (KY for short).

We study left-invariant Conformal Killing Yano 2-forms on Lie groups endowed with a left-invariant metric. We determine, up to isometry, all 5-dimensional metric Lie algebras under certain conditions, admitting a CKY 2-form. Moreover, a characterization of all possible CKT tensors on those metric Lie algebras is exhibited.

7.8. Conformal and CR mappings on stratified groups

Alessandro Ottazzi (University of New South Wales)

Wed 9 December 202014:20

Dr Alessandro Ottazzi

In this talk, I will discuss a class of stratified groups that admit a CR structure. We show that for every sub-Riemannian distance that is compatible with the CR structure, conformal mappings coincide with CR and anti-CR automorphisms. Moreover, we construct polynomial embeddings into $\mathbb{C}^N$ for some of these CR groups. This work is in collaboration with Michael Cowling, Ji Li, and Qingyan Wu.

8. Dynamical Systems and Ergodic Theory

8.1. Random Open Interval Maps

Jason Atnip (University of New South Wales)

Wed 9 December 202012:50

Dr Jason Atnip

In the theory of open dynamical systems one takes a dynamical system and then puts a hole (a set of positive measure) in the phase space through which trajectories gradually escape. In this setting one is typically interested in the rate at which mass escapes through the hole. In this talk we will consider a random map of the interval together with a random hole which depends on the fibers. We show that under mild hypotheses there exists a unique conditionally invariant measure which is absolutely continuous with respect to the conformal measure of the original (closed) dynamical system. Furthermore, we show that this conditionally invariant measure satisfies an exponential decay of correlations. Additionally, we prove a formula, in the spirit of Bowen, for the Hausdorff dimension of the points which never enter the hole.

8.2. On uncertain conclusions of Lagrangian coherence

Sanjeeva Balasuriya (The University of Adelaide)

Thu 10 December 202014:00

Mx Sanjeeva Balasuriya

Fluid and energy transport occurs inhomogeneously in many geophysical and laboratory flows of interest, with regions of relatively coherent regions interspersed with highly mixing regions. Since these move around with time in unsteady flows, capturing them is an ambiguous task, tackled via the many techniques which have come to be known as "Lagrangian coherent structure" identification. There is an emerging interest in the additional difficulties that Eulerian velocity data used in this process in realistic flows suffers from uncertainty in observations/measurements, and is available only on a spatio-temporal grid. This talk addresses several implications of these issues: uncertainty in eventual Lagrangian locations via a theoretical stochastic differential equations approach, a derived uncertainty in the finite-time Lyapunov exponent field, and the numerical robustness of several other Lagrangian coherent structure methods in a computational fluid dynamics flow. This work is partly in collaboration with Aleksandar Badza and Trent Mattner.

8.3. On the existence and number of random invariant measures for higher dimensional random dynamical systems

Fawwaz Batayneh (University of Queensland)

Wed 9 December 202013:20
Mr Fawwaz Batayneh

We investigated the existence of random absolutely continuous invariant measures (ACIP) for higher dimensional random dynamical systems. We proved that these systems are quasi-compact and admit a finite number of ergodic ACIPs. In this talk, I will focus on providing upper bounds for the number of these ergodic ACIPs.

8.4. Rigorous justification of the Whitham modulation theory for equations of NLS type

William Clarke (The University of Sydney)

Wed 9 December 202016:50
Mr William Clarke

We study the modulational stability of periodic travelling wave solutions to equations of nonlinear Schrödinger type. In particular, we prove that the characteristics of the quasi-linear system of equations resulting from a slow modulation approximation satisfy the same equation, up to a change in variables, as the normal form of the linearized spectrum crossing the origin. This normal form is taken from a recent paper, where Leisman et al. compute the spectrum of the linearized operator near the origin via an analysis of Jordan chains. We derive the modulation equations using Whitham's formal modulation theory, in particular the variational principle applied to an averaged Lagrangian. We use the genericity conditions assumed in the rigorous theory of Leisman et al. to direct the homogenization of the modulation equations. As a result of the agreement between the equation for the characteristics and the normal form from the linear theory, we show that the hyperbolicity of the Whitham system is a necessary condition for modulational stability of the underlying wave.

8.5. Identifying Coherent Ocean Features From Swarms of Virtual Drifters

Michael Charles Denes (UNSW Sydney)

Tue 8 December 202015:50
Mr Michael Charles Denes

Ocean flows are dominated by coherent structures, like eddies, fronts, and gyres, with lifetimes longer than typical dynamical timescales. These features are embedded within and transported by the surrounding fluid flow, and are frequently referred to as Lagrangian Coherent Structures (LCSs). Due to their capacity to transport water and material over large distances, LCSs play an important role in climate, biogeochemistry, and small-scale mixing. A range of powerful techniques have been adopted from the dynamical systems theory literature to identify coherent features in fluid flows. The most widely used of these methods require Eulerian observations of ocean currents, that is, on a fixed grid. However, due to the paucity of available observations of oceanic velocity fields with sufficient spatio-temporal resolution, it is often difficult to identify and track LCSs in the real ocean. Typically real ocean data come from Lagrangian observations, such as those from drifters, gliders, and ARGO floats. Therefore, an outstanding challenge in Mathematical Oceanography is the development and validation of new methods for identifying LCSs in real ocean data. One recent method uses the transfer (or dynamic Laplace) operator to identify regions of phase space that form finite-time coherent sets. Finite-time coherent sets are sets or regions of fluid flow that for a finite period of time minimally mix with the remainder of the flow. In this talk we will provide an overview of Finite-Time Coherent Sets and the dynamic Laplacian approach using finite element methods to compute them, and discuss problems faced when implementing this method in real world applications. We will provide an application on eddies, specifically Agulhas rings, where we try to understand how they form, travel, and ultimately decay.

8.6. Quantitative twisted recurrence

Alexander Fish (The University of Sydney)

Wed 9 December 202013:50

Dr Alexander Fish

The recurrence is one of the fundamental phenomena in Ergodic Theory. It was noticed by Furstenberg that the recurrence in dynamics is equivalent to the intersectivity in arithmetics. In this talk we will discuss a new version of the intersectivity property that we call a (quantitative) twisted recurrence. We will relate it with a dynamical property of a (quantitative) pleasant (semi-)group action of $\mathbb{Z}^d$. We will overview a few recently proved examples of pleasant and quantitatively pleasant actions, and its arithmetic consequences. The talk is based on joint works with M. Björklund and K. Bulinski.

8.7. Random dynamical systems and their Lyapunov Oseledets spectrum

Cecilia Gonzalez-Tokman (The University of Queensland)

Wed 9 December 202015:50

Dr Cecilia Gonzalez-Tokman

Random dynamical systems are important to describe phenomena whose governing rules change over time, due to external forcing. The transfer operator approach provides a convenient way to investigate global aspects of the long term behaviour of these systems, including invariant measures and rates of decay of correlation, among others. In this talk, we will present recent results about the stability of the so-called Lyapunov–Oseledets spectrum, which shed some light on the question: How do small dynamic changes affect the long term global properties of the system?

8.8. Simulation of non-Lipschitz stochastic differential equations driven by α-stable noise: a method based on deterministic homogenisation

Georg Gottwald (The University of Sydney)

Thu 10 December 202014:30

Prof Georg Gottwald

The talk introduces an explicit method to integrate α-stable stochastic differential equations (SDEs) with non-Lipschitz coefficients. To mitigate against numerical instabilities caused by unbounded increments of the Lévy noise, we use a deterministic map which has the desired SDE as its homogenised limit. Moreover, our method naturally overcomes difficulties in expressing the Marcus integral explicitly. We present an example of an SDE with a natural boundary showing that our method respects the boundary whereas Euler-Maruyama discretisation fails to do so. As a by-product we devise an entirely deterministic method to construct α-stable laws.
This is joint work with Ian Melbourne

8.9. Dynamics of heterogeneous networks of Winfree oscillators

Carlo Laing (Massey University)

Tue 8 December 202014:50

Prof Carlo Laing

Winfree oscillators are phase oscillator models of neurons, characterised by their phase response curve and pulsatile interaction function. We use the Ott/Antonsen ansatz to study large heterogeneous networks of Winfree oscillators, deriving low-dimensional differential equations which describe the evolution of the expected state of an oscillator. We consider the effects of correlations between an oscillator's in-degree and out-degree, and between in the in- and out-degrees of an "upstream" and a "downstream" oscillator (degree assortativity). We also consider correlated heterogeneity, where some property of an oscillator is correlated with a structural property such as degree. The results give insight into the effects of the structure of a network on its dynamics.

8.10. Contact and delay: loss of normal hyperbolicity in general slow-fast dynamical systems

Ian Lizarraga (The University of Sydney)

Wed 9 December 202016:20

Dr Ian Lizarraga

Singularly-perturbed dynamical systems can be used to model important phenomena that emerge from timescale splitting (where 'slow' versus 'fast' processes can be distinguished). This includes solutions like relaxation oscillations and mixed-mode oscillations. An essential step in this analysis is to classify how the slow manifolds lose normal hyperbolicity, but this step is nontrivial for many systems that are not in a 'standard' form.

This talk describes a computable, coordinate-independent framework for this classification, for slow-fast dynamical systems in a general form. For the case of zero-eigenvalue crossings, we show that the theory of contact singularities between smooth manifolds is the natural framework to classify folds, cusps, and higher-order A_k singularities. We also provide a coordinate-independent classification for the case of complex eigenvalue crossings, which heralds delayed Hopf bifurcations. We highlight several examples, including a new, minimal construction of a *nonclassical* mixed-mode oscillation.

8.11. Searching for an ergodic PIG: unresolved issues in simulating extremely multiscale systems

John Maclean (The University of Adelaide)

Tue 8 December 202015:20

Dr John Maclean

This talk addresses issues that arise when a modelling problem includes many fast time scales, and particularly when some or all of the fast time scales are stochastic. Well established theory provides analytical solutions by integrating out the fast dynamics with respect to an invariant measure. We are interested in cases where the analytical solution is too complicated to compute directly. The 'Equation Free' approach is to try to infer the slow dynamics from brief bursts of simulation on fast time scales. We introduce a fast, efficient Equation Free algorithm, called PIG, and compare it to deterministic and stochastic multiscale integrators. The advantages of PIG over related deterministic multiscale integrators motivate us to seek a stochastic/ergodic version, suitable for parallelisation.

8.12. Dynamical analysis of a reduced model for the North Atlantic Oscillation

Courtney Rose Quinn (CSIRO)

Tue 8 December 202016:20

Dr Courtney Quinn, Dr Dylan Harries, Dr Terence J. O'Kane

While clustering techniques are highly useful in identifying regimes of large-dimensional data, some methods (such as FEM-BV-VAR) also produce time-dependent models for the corresponding regime dynamics. We investigate these reduced models in the context of climate teleconnections, where the FEM-BV-VAR methodology is applied to atmospheric reanalysis data of a region defined to capture the North Atlantic Oscillation (NAO). The technique provides the model parameters for each cluster state, and the temporal behaviour is given in terms of a time-dependent switching between the respective cluster states. Using the resulting cluster affiliations for each day, we set the switching sequence a priori to define a non-smooth linear delayed map that we use to analyze the dynamics associated with the resulting cluster-based model. We use a method for computing the covariant Lyapunov vectors (CLVs) over various time windows, where short windows produce a set of mixed singular vectors and longer windows approximate the asymptotic CLVs. The growth rates and alignment of the resulting time-dependent vectors are then analyzed with a particular focus on indicators of transitions between the states. We find that the window chosen to compute the vectors acts as a filter on the dynamics, with short windows capturing the dynamics of individual transitions and long windows identifying low-frequency variability. We observe an emergent annual signal manifest in the alignment of the CLVs characteristic of the observed seasonality in the respective NAO and Atlantic ridge (AR) indices. Analysis of the average finite-time growth rates reveals the NAO- as the most unstable state relative to the NAO+, with persistent AR states largely stable.

8.13. Higher Cheeger and dynamic Cheeger constant bounds in terms of Laplace-Beltrami and dynamic Laplacian eigenvalues

Christopher P Rock (UNSW Sydney)

Thu 10 December 202013:30

Mr Christopher P Rock

Coherent sets in purely advective, nonautonomous dynamical systems are subsets of the phase space which interact minimally with the rest of the phase space under infinitesimal mixing. Coherent sets can be defined via a generalisation of the *higher-order Cheeger constants* of a Riemannian manifold. The higher-order Cheeger constants are the minima for a sequence of geometric optimisation problems, and play a central role in spectral geometry. No general closed-form expressions exist for the non-trivial Cheeger constants, but there are well-known inequalities relating the first non-trivial Cheeger constant to the first non-trivial eigenvalue of the *Laplace-Beltrami operator*. In this talk, we discuss some new and existing inequalities relating the higher-order Cheeger constants to the higher Laplace-Beltrami eigenvalues. We then introduce the *higher-order dynamic Cheeger constants*, which provide a numerical description of the coherent sets in the phase space of a dynamical system. Finally, we discuss some bounds relating the higher-order dynamic Cheeger constants to the eigenvalues of the *dynamic Laplacian* operator, which generalise the bounds on the higher-order Cheeger constants.

8.14. Pesin sets with exponentially small tails and exponential mixing for Anosov flows

Luchezar Stoyanov (The University of Western Australia)

Wed 9 December 202015:20
Prof Luchezar Stoyanov

In the first part of the talk some joint results with Sebastien Gouëzel (Université de Nantes, France) will be described concerning existence of Pesin sets P *with exponentially small tails* in the general setting of a transitive subshift T of finite type on a symbol space Σ with respect to a Gibbs measure μ determined by a Hölder continuous potential. These are Pesin subsets P of Σ so that for every $n \geq 1$ the measure of the set of points $x \in \Sigma$ so that $T^j(x) \notin P$ for all $j = 0, 1, \ldots, n-1$ is exponentially small in n. The existence of Pesin sets with exponentially small tails with respect to a Gibbs measure μ can be used to prove exponential mixing for that measure e.g. for contact Anosov flows on manifolds of arbitrarily large dimension. Such results will be the described in the second part of the talk.

8.15. Geometric singular perturbation theory beyond the standard form

Martin Wechselberger (The University of Sydney)

Thu 10 December 202013:00
Prof Martin Wechselberger

In this talk I will review geometric singular perturbation theory, but with a twist— I focus on a coordinate-independent setup of the theory. The need for such a theory *beyond the standard form* is motivated by looking at, e.g., biochemical reactions or mechanical or electronic oscillators. While the corresponding models incorporate processes evolving on disparate timescales leading to multiple time-scale dynamics, not all of these models take globally the form of a standard system. Thus from an application point of view, it is desirable to provide tools to analyse multiple time-scale problems in a coordinate-independent manner.

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

9.1. Twisted Steinberg algebras

Becky Armstrong (Victoria University of Wellington)

Wed 9 December 202013:50
Dr Becky Armstrong

Steinberg algebras are a purely algebraic analogue of groupoid C*-algebras that generalise both Leavitt path algebras and Kumjian–Pask algebras. Since their introduction in 2010, Steinberg algebras have served as a bridge to facilitate the transfer of various concepts and techniques between the algebraic and analytic settings. Given the importance of *twisted* groupoid C*-algebras in C*-algebraic research (for instance, every classifiable C*-algebra is a twisted groupoid C*-algebra), a natural question to ask is whether Steinberg algebras can be twisted in an analogous way. In this talk, I will introduce two different notions of a *twisted Steinberg algebra*. I will describe the relationship between the two, and will discuss uniqueness theorems and simplicity of these algebras. (This is joint work with Lisa Orloff Clark, Kristin Courtney, Ying-Fen Lin, Kathryn McCormick, and Jacqui Ramagge.)

9.2. Jones actions of Thompson groups and others

Arnaud Brothier (UNSW Sydney)

Thu 10 December 202014:00
Dr Arnaud Brothier

In his quest in constructing conformal field theories Vaughan Jones found an efficient machine to construct actions of groups like the Thompson groups. I will present a general overview of this technology. In particular, I will explain how to construct unitary representations but also new groups providing explicit examples. Some of the work presented was joint with Vaughan Jones.

9.3. Gelfand-Kolmogorov families

Ian Doust (University of New South Wales)

Thu 10 December 202013:00

Dr Ian Doust

The Gelfand–Kolmogorov Theorem says that the algebra structure of the space $C(K)$ of continuous functions on a compact Hausdorff space K is completely encoded in the topological structure of the set K. That is the algebras $C(K_1)$ and $C(K_2)$ are isomorphic if and only if K_1 and K_2 are homeomorphic. It is natural to ask whether $C(K)$ spaces could be replaced by other families of algebras.

The spaces $AC(\sigma)$ of absolutely continuous functions on a nonempty compact subset σ of the plane arise in attempts to generalize the theory of normal operators to Banach spaces. It is known that there is no 'Gelfand–Kolmogorov Theorem' for these spaces which hold for all compact subsets of $\mathbb{C}$. Positive results are possible however if one restricts one's attention to certain families of compact sets. In this talk I shall discuss some recent results (with Shaymaa Al-shakarchi) on identifying 'Gelfand–Kolmogorov' families of compact subsets. Somewhat surprisingly, some of these results require facts from graph theory in their proof.

9.4. The étale category associated to an algebraic theory

Richard Garner (Macquarie University)

Wed 9 December 202014:20

Dr Richard Garner

In this talk, we explain how every equational algebraic theory has an associated source-étale topological category which captures, in some sense, the computational dynamics of that theory. We illustrate this by describing algebraic theories whose associated computational dynamics are described by étale topological groupoids of a kind familiar from non-commutative geometry.

9.5. On the g-angle between two subspaces of a normed space

Hendra Gunawan (Bandung Institute of Technology)

Thu 10 December 202014:30

H. Gunawan and M. Nur

We introduce a new 2-norm on a normed space using a semi-inner product g on the space. Using this 2-norm, we propose a formula for the g-angle between 2-dimensional subspaces of the space. Our formula serves as a revision of the one proposed by Nur et al. in 2018.

9.6. Lipschitz estimates in quasi-Banach Schatten ideals

Edward McDonald (UNSW Sydney)

Thu 10 December 202013:30

Dr Edward McDonald

We study the class of functions f on $\mathbb{R}$ satisfying a Lipschitz estimate in the Schatten ideal $\mathcal{L}_p$ for $0 < p \leq 1$. The corresponding problem with $p \geq 1$ is well studied, but the quasi-Banach range $0 < p < 1$ is by comparison poorly understood. Using techniques from wavelet analysis, we prove that Lipschitz functions belonging to the homogeneous Besov class $\dot{B}^{\frac{1}{p}}_{\frac{p}{1-p},p}(\mathbb{R})$ obey the estimate

$$\|f(A) - f(B)\|_p \leq C_p(\|f'\|_{L_\infty(\mathbb{R})} + \|f\|_{\dot{B}^{\frac{1}{p}}_{\frac{p}{1-p},p}(\mathbb{R})})\|A - B\|_p$$

for all bounded self-adjoint operators A and B with $A - B \in \mathcal{L}_p$. In the case $p = 1$, our methods recover and provide a new perspective on a result of Peller that $f \in \dot{B}^1_{\infty,1}$ is sufficient for a function to be Lipschitz in $\mathcal{L}_1$. We also provide related Hölder-type estimates, extending results of Aleksandrov and Peller. In addition, we prove the surprising fact that non-constant periodic functions on $\mathbb{R}$ are not Lipschitz in $\mathcal{L}_p$ for any $0 < p < 1$. This implies the existence of counterexamples to a 1991 conjecture of Peller that $f \in \dot{B}^{1/p}_{\infty,p}(\mathbb{R})$ is sufficient for f to be Lipschitz in $\mathcal{L}_p$. Joint work with F. Sukochev.

9.7. From Bass-Serre Theory to Cuntz-Pimsner algebras

Alexander Mundey (University of Wollongong)

Wed 9 December 202013:20

Dr Alexander Mundey

Graphs of groups were introduced by Bass and Serre in the 70s as a tool to study the structure of groups via their actions on trees. Bass-Serre Theory, as it is now known, establishes a one-to-one correspondence between graphs of groups and group actions on trees. On the other hand, Cuntz-Pimsner algebras provide a C^*-algebraic framework for encoding non-commutative dynamical systems. In this talk I give an overview of some recent work with Adam Rennie in which we construct a Cuntz-Pimsner algebra from a graph of groups. The algebra is Morita equivalent to a crossed product arising from the associated group action on a tree and allows for the calculation of invariants such as K-theory.

9.8. Reconstruction of graphs from C*-algebraic data

Aidan Sims (University of Wollongong)

Wed 9 December 202012:50

Prof Aidan Sims

C*-algebras are often viewed as a setting for encoding representations of irreversible dynamics. One of the most successful and influential examples of this is the study of graph C*-algebras, which took off in the late 1990's and is still going strong. For the most part the idea is to use invariants such as ideal-structure or K-theory of the C*-algebra to extract invariants of the underlying graph. But recently it has emerged that in some instances C*-algebraic data can be used to recover the graph in its entirety. I will discuss some recent results in this direction. The talk incorporates result from joint work with Brownlowe, Laca and Robertson, and from joint work with Eilers and Ruiz.

10. Geometric Analysis

10.1. Constant rank theorems for prescribed curvature equations

Paul Bryan (Macquarie University)

Wed 9 December 202014:20

Mr Paul Bryan

Constant rank theorems provide quantitative rigidity statements for the hessian of solutions of elliptic equations. They may be used in proving, among other things that solutions of certain fully non-linear prescribed curvature equations are strictly convex. This amounts to a statement of non-degeneracy and in general, a quantification of the extent of non-degeneracy.

10.2. Spectral gap in hyperbolic space

Julie Clutterbuck (Monash University)

Thu 10 December 202013:00

Dr Julie Clutterbuck

We study the gap between the two smallest eigenvalues of the Laplace operator on a convex bounded domain. If the domain is in flat space or on the sphere, this gap is bounded below. In this talk, I will describe why in hyperbolic space, this doesn't hold: the gap for domains of any size can be arbitrarily small. This is joint work with T Bourni, X H Nguyen, A Stancu, G Wei and V Wheeler.

10.3. On the signature of the Ricci curvature on nilmanifolds

Ramiro Augusto Lafuente (The University of Queensland)

Thu 10 December 202013:30

Dr Ramiro Augusto Lafuente, Dr Romina M Arroyo

The Ricci curvature is a $0,2$-tensor naturally associated to any Riemannian manifold. In this talk, I will describe joint work with Romina Arroyo in which we completely describe all possible signatures for the Ricci curvature of invariant metrics on nilmanifolds, in terms of purely algebraic data. The proof has two main ingredients: the construction of a metric whose Ricci curvature has maximal nullity, and an implicit function theorem argument. The former is achieved using elementary ideas from GIT.

10.4. Non-compact L_p-Minkowski problems

Jiakun Liu (University of Wollongong)

Thu 10 December 202016:00

Dr Jiakun Liu

In this talk, we introduce a class of noncompact L_p-Minkowski problems, and prove the existence of complete, noncompact convex hypersurfaces whose p-curvature function is prescribed on a domain in the unit sphere. This problem is related to the solvability of Monge-Ampère equations subject to certain boundary conditions depending on the value of p. The special case of $p = 1$ was previously studied by Pogorelov and Chou-Wang. Here, we give some sufficient conditions for the solvability for general p's. This is joint work with Yong Huang at Hunan University.

10.5. Higher order curvature flow of plane curves with generalised Neumann boundary conditions

James McCoy (The University of Newcastle)

Wed 9 December 202015:50

Assoc Prof James McCoy

We consider the parabolic polyharmonic diffusion and the L^2-gradient flow for the square integral of the m-th arclength derivative of curvature, for regular closed curves evolving with generalised Neumann boundary conditions. In the polyharmonic case, we prove that if the curvature of the initial curve is small in L^2, then the evolving curve converges exponentially in the C^∞ topology to a straight horizontal line segment. The same behaviour is shown for the L^2-gradient flow provided the energy of the initial curve is sufficiently small. In each case the smallness conditions depend only on m. This is joint work with Glen Wheeler and Yuhan Wu.

10.6. On the Mean First Arrival Time of Brownian Particles on Riemannian Manifolds

Medet Nursultanov (The University of Sydney)

Thu 10 December 202015:30

Mr Medet Nursultanov

We use geometric microlocal methods to compute an asymptotic expansion of mean first arrival time for Brownian particles on Riemannian manifolds. This approach provides a robust way to treat this problem, which has thus far been limited to very special geometries.

10.7. Maxima of the scalar curvature functional on compact homogeneous spaces

Artem Pulemotov (The University of Queensland)

Thu 10 December 202014:00

Dr Artem Pulemotov

The talk will focus on a new comprehensive result concerning the prescribed Ricci curvature problem on compact homogeneous spaces. We will explain how this result can be used to treat cases inaccessible to previously known methods. Joint work with Wolfgang Ziller (Penn).

10.8. Nonuniqueness question in mean curvature flow

Lu Wang (California Institute of Technology)

Wed 9 December 202013:20

Prof Lu Wang

Mean curvature flow is the gradient flow of area functional that decreases the area in the steepest way. In general the flow will develop singularities in finite time. It is known that there may not be a unique way to continue the flow through singularities. In this talk, we will discuss some global features of the space of mean curvature flows that emerge from cone-like singularities. This is joint with Jacob Bernstein.

10.9. The entropy flow for planar curves

Glen Wheeler (University of Wollongong)

Wed 9 December 202016:20

Dr Glen Wheeler

In this talk, we describe a new flow for convex planar curves that decreases the entropy. This may be ill-advised, since the energy is not bounded from below, but everything turns out well in the end. This flow has a number of remarkable properties that we use to obtain a surprisingly strong convergence result. This work is joint with Lachlann O'Donnell and Valentina-Mira Wheeler.

10.10. Curvature flow model for dorsal closure

Valentina-Mira Wheeler (University of Wollongong)

Wed 9 December 202015:20

Dr Valentina-Mira Wheeler

We present the use of a non local curve shortening flow with mixed boundary conditions in the modelling of dorsal closure. Joint work with Shuhui He, Ben Whale and Glen Wheeler.

10.11. Explicit Łojasiewicz inequalities for mean curvature flow shrinkers

Jonathan Julian Zhu (Australian National University)

Thu 10 December 202015:00

Dr Jonathan Julian Zhu

Łojasiewicz inequalities are a popular tool for studying the stability of geometric structures. For mean curvature flow, Schulze used Simon's reduction to the classical Łojasiewicz inequality to study compact tangent flows. Colding and Minicozzi instead used a direct method to prove Łojasiewicz inequalities for round cylinders. We'll discuss similarly explicit Łojasiewicz inequalities and applications for other shrinking cylinders and Clifford shrinkers.

11. Harmonic Analysis

11.1. Properties of higher-dimensional Clifford Prolate Spheroidal Wave Functions

Hamed Baghal Ghaffari (The University of Newcastle)

Wed 9 December 202015:20

Mr Hamed Baghal Ghaffari

In this talk, we introduce important properties of higher-dimensional Clifford Prolate Spheroidal Wave Functions (CPSWFs). We first review the Clifford Legendre polynomials, and the Clifford Prolate differential equation whose eigenfunctions constitute what we call CPSWFs. We show that the radial part of CPSWFs satisfies the Sturm–Liouville theory which allows us to talk about relevant properties including the zeros of CPSWFs. We present that CPSWFs are also the eigenfunctions of an appropriate time-frequency limiting operator. We mention that the eigenvalues of the latter operator have a non-degeneracy property, among others. Finally, we highlight some spectral concentration and spectrum accumulation properties of the CPSWFs.

11.2. Almost everywhere convergence of Bochner-Riesz means for the Hermite operators

Peng Chen (sun yat sen university)

Tue 8 December 202016:20

Peng Chen, Xuan Thinh Duong, Danqing He, Sanghyuk Lee and Lixin Yan

Let $H = -\Delta + |x|^2$ be the Hermite operator in $\mathbb{R}^n$. In this talk we discuss almost everywhere convergence of the Bochner-Riesz means associated with H which is defined by $S_R^\lambda(H)f(x) = \sum\limits_{k=0}^{\infty} \big(1 - \frac{2k+n}{R^2}\big)_+^\lambda P_k f(x)$. Here $P_k f$ is the k-th Hermite spectral projection operator. For $2 \le p < \infty$, we prove that

$$\lim_{R\to\infty} S_R^\lambda(H)f = f \quad \text{a.e.}$$

for all $f \in L^p(\mathbb{R}^n)$ provided that $\lambda > \lambda(p)/2$ and $\lambda(p) = \max\big\{n\big(1/2 - 1/p\big) - 1/2,\, 0\big\}$. Conversely, we also show the convergence generally fails if $\lambda < \lambda(p)/2$ in the sense that there is an $f \in L^p(\mathbb{R}^n)$ for

$2n/(n-1) \leq p$ such that the convergence fails. This is in surprising contrast with a.e. convergence of the classical Bochner-Riesz means for the Laplacian. For $n \geq 2$ and $p \geq 2$ our result tells that the critical summability index for a.e. convergence for $S_R^\lambda(H)$ is as small as only the *half* of the critical index for a.e. convergence of the classical Bochner-Riesz means. When $n = 1$, we show a.e. convergence holds for $f \in L^p(\mathbb{R})$ with $p \geq 2$ whenever $\lambda > 0$. Compared with the classical result due to Askey and Wainger who showed the optimal L^p convergence for $S_R^\lambda(H)$ on $\mathbb{R}$ we only need smaller summability index for a.e. convergence.

11.3. A Calderón-Zygmund decomposition for von Neumann algebra valued functions

José Manuel Conde Alonso (Universidad Autónoma de Madrid)

Thu 10 December 202013:00
Prof José Manuel Conde Alonso

The classical Calderón-Zygmund decomposition is a fundamental tool that helps one study endpoint estimates near L^1. In this talk, we shall study an extension of the decomposition to a particular operator valued setting where noncommutativity makes its appearance, allowing to get rid of the (usually necessary) UMD property of the Banach space where functions take values.

Based on joint work with L. Cadilhac and J. Parcet.

11.4. Flag Hardy spaces

Michael Cowling (University of New South Wales)

Wed 9 December 202012:50
Prof Michael Cowling

The flag structure on the Heisenberg group arises naturally in problems in complex analysis. Flag Hardy spaces on the Heisenberg group were introduced by Han, Lu and Saywer. However, they were characterised only in terms of square functions. In recent work with Chen, Lee, Li, and Ottazzi, we have characterised flag Hardy spaces in various ways, including by atomic decompositions and singular integrals as well as square functions, and used these characterisations to sharpen the Marcinkiewicz multiplier theorem for the joint spectral calculus for the usual sub-Laplacian and differentiation in the central variable. This talks surveys our results and discusses the innovations that we have introduced.

11.5. A feasibility approach to quaternion-valued wavelet construction

Neil Kristofer Dizon (The University of Newcastle)

Wed 9 December 202015:50
Neil Kristofer Dizon

The construction of smooth, nonseparable and compactly supported multidimensional wavelets has been recently formulated as feasibility problems that were successfully solved using projection algorithms. In another timeline, the development of Clifford-Fourier transform has laid down the foundations for generalizing the classical Fourier and wavelet analysis to provide the basic theory required for the construction of quaternion-valued wavelets with compact support, prescribed regularity, and multiresolution structure. In this talk, I will present a formulation of quaternion-valued wavelet construction as a feasibility problem thereby solving it to obtain novel quaternion-valued wavelets on the plane.

11.6. L^p estimates and weighted estimates of fractional maximal rough singular integrals on homogeneous groups

Zhijie Fan (sun yat sen university)

Thu 10 December 202014:00
Dr Zhijie Fan

In this talk, I discuss some recent progress on Lp boundedness and weighted boundedness of fractional maximal singular integral operators with homogeneous convolution kernel on homogeneous group of dimension Q, which extends many important results in Euclidean space to general homogeneous groups. This is a joint work with Yanping Chen and Ji Li.

11.7. Bourgain space associated to Schrodinger operator

Zihua Guo (Monash University)

Thu 10 December 202013:30

Zihua Guo

Bourgain space Xsb method, developed in the 1990s, is very useful in the study of nonlinear dispersive equations. We will talk about the space associated to the Schrodinger operator and give some applications.

11.8. The Heisenberg group and pseudodifferential calculus in new settings

Sean Harris (The Australian National University)

Wed 9 December 202014:20

Mr Sean Harris

I will talk about the significance of Heisenberg groups within harmonic analysis, including how the representation theory of Heisenberg groups can be used to give an alternate origin to the Fourier transform, and how the Heisenberg group unifies different versions of pseudodifferential calculus. Next I will detail an application of the Heisenberg group and pseudodifferential operators in some of my own work, in which it is key to proving L^p bounded functional calculus results for the Ornstein-Uhlenbeck operator (an example of a Witten Laplacian). Finally, I will present some of my ongoing research into extending the notion of Heisenberg groups towards non-Abelian LC groups and the possible implications for representation theory and harmonic analysis of such groups.

11.9. Wave equations with rough coefficients on L^p spaces

Andrew Hassell (Australian National University)

Tue 8 December 202014:50

Prof Andrew Hassell

This is joint work with Jan Rozendaal. We consider the wave equation with rough, for example $C^{1,1}$, coefficients. We show that the wave equation is well-posed with initial data in Sobolev spaces over the Hardy spaces H^p_{FIO} adapted to Fourier integral operators, introduced in previous work with Portal and Rozendaal. This gives results for such wave equations with L^p initial data, where there is an unavoidable loss of derivatives for all $p \neq 2$, using embedding theorems. However, on the H^p_{FIO} spaces there is *no* loss of derivatives, illustrating that these spaces are the "correct" L^p-type spaces for solving wave equations — and work as well for rough as for smooth coefficients.

11.10. Clifford translations, wavelets and splines

Jeffrey Hogan (The University of Newcastle)

Wed 9 December 202014:50

Dr Jeffrey Hogan

Modern constructions of multi-dimensional wavelets and splines rely on translations along uniform grids that run parallel to the coordinate axes. In the wavelet case this leads to a bias towards separability, while in the spline case it causes rotational non-covariance. In this talk we introduce a one-parameter family of Clifford-analytic translations and modulation operators that act isotropically on Clifford-valued functions on n-dimensional Euclidean space. Applications to the construction of higher-dimensional wavelets, splines and bandpass prolates will be investigated.

11.11. Operator θ-Hölder functions with respect to L_p-norms, $0 < p \leq \infty$.

Jinghao Huang (University of New South Wales)

Thu 10 December 202015:00

Dr Jinghao Huang

The study of operator Hölder functions has a long history and plays an important role in the perturbation theory of linear operators on a Hilbert space. The starting point is the so-called Powers–Strømer inequality [Comm. Math. Phys. 1970] (and its generalization, the so-called Birman–Koplienko–Solomjak inequality [IVUZM, 1975]). Over the past decades, many mathematicians enlarged the classes of functions or the quasi-norms for which the inequality holds. Aleksandrov and Peller [JFA, 2010] showed Holder functions are not necessarily operator-Holder. However, it was unknown whether the simplest example of Holder functions, the fractional power functions, are operator-Holder for every Lp-norm or not before being proved by E. Ricard recently [Adv. Math. 2018]. After reviewing the background material, I will sketch Ricard's proof and present the joint work with F. Sukochev and D. Zanin, which extends several existing results.

11.12. Multilinear weighted estimates in product spaces

Kangwei Li (Tianjin University)

Thu 10 December 202014:30

Prof Kangwei Li

In the one-parameter situation, the very influential paper by Lerner et. al. introduced the Muckenhoupt weights in the multilinear setting and it was shown that one can get related weighted estimates for the maximal function and singular integrals. Around 10 years ago, such class of weights were also introduced in the multilinear multi-parameter context, however, the related weighted estimates were only known for the maximal function.

In this talk, I will talk about the recent progress on the multilinear weighted estimates for singular integrals in product spaces. Our result completes the qualitative weighted theory in this setting. Extrapolation gives powerful applications – for example, a free access to mixed-norm estimates in the full range of exponents.

11.13. Fixed time Lp estimates for wave equations with structured Lipschitz coefficients

Pierre Portal (Australian National University)

Tue 8 December 202015:50

Dr Pierre Portal

A celebrated result of Peral/Miyachi from the 1980's describes the optimal loss of derivatives in well posedness results for the standard wave equation $\partial_t^2 u = \Delta u$ on $\mathbb{R}^d$. In this talk we discuss a generalisation of this result, where the Laplacian is replaced by an operator with Lipschitz coefficients that have an appropriate algebraic structure. The result is somewhat surprising because the related Strichartz estimates are known to fail for general operators with coefficients rougher than $C^{1,1}$. The heart of the proof is the construction of an appropriate Hardy space that is invariant under the action of the relevant wave group. The talk is based on a joint paper with Dorothee Frey (Karlsruhe), building on work with Andrew Hassell (ANU) and Jan Rozendaal (IMPAN).

11.14. Hardy spaces and harmonic weights

Adam Sikora (Macquarie University)

Wed 9 December 202013:50

Dr Adam Sikora

We investigate the Hardy space H^1_L associated with a self-adjoint operator L. We assume that there exists an L-harmonic non-negative function h such that the semigroup $\exp(-tL)$, after applying the Doob transform related to h, satisfies the upper and lower Gaussian estimates. Under this assumption we describe an illuminating characterisation of the Hardy space H^1_L in terms of a simple atomic decomposition associated with the L-harmonic function h.

It is a joint work with Marcin Preisner and Lixin Yan.

11.15. Tight Framelets and Fast Framelet Filter Bank Transforms on Manifolds

Yuguang Wang (Max Planck Institute; UNSW)

Wed 9 December 202016:20

Dr Yuguang Wang

Data in practical application with some structure can be viewed as sampled from a manifold, for instance, data on a graph and in astrophysics. A smooth and compact Riemannian manifold M, including examples of spheres, tori, cubes and graphs, is an important geometric structure. In this work, we construct a type of tight framelets using quadrature rules on M to represent the data (or a function) and to exploit the derived framelets to process the data (for example, image and signal processing on the sphere or graphs).

One critical computation for framelets is to compute, from the framelet coefficients for the input data (which are assumed at the highest level), the framelet coefficients at lower levels, and also to evaluate the function values at new nodes using the framelet representation. We design an efficient computational strategy, which we call fast framelet filter bank transform (FMT), to compute the framelet coefficients and to recover the function. Assuming the fast Fourier transform (FFT) and using quadrature rules on the manifold M, the FMT has the same computational complexity as the FFT. Numerical examples illustrate the efficiency and accuracy of the algorithm for the framelets.

This talk is based on joint works with Quoc T. Le Gia, Ian Sloan and Rob Womersley (UNSW Sydney), Houying Zhu (Macquarie University) and Xiaosheng Zhuang (City University of Hong Kong).

12. Inclusivity, diversity, and equity in mathematics

12.1. Equity considerations in the design of online mathematics outreach

Yudhistira Andersen Bunjamin (UNSW Sydney)

Wed 9 December 202012:50

Yudhistira A. Bunjamin, Robert Cantwell, Diana Combe, Aditya Ganguly, Amanda Michels, Hanna Nie, Aldhytha Karina Sari, Tom Stindl

With the COVID-19 restrictions in place throughout 2020, much science outreach has either been cancelled or gone online. In June this year, the School of Mathematics and Statistics participated in an event called *Experience UNSW Science Day* which is an event organised by UNSW's Division of External Relations. This is an annual event for high school students in NSW aimed at giving them a taste of what it is like to study Science at UNSW. Typically, the event is held on-campus and students participate in a number of activities organised by various schools in the faculty.

The School of Mathematics and Statistics participated in this year's online event by designing and presenting two activities, one in mathematics and one in statistics, which students could perform at home with regular household items. These activities were designed in-line with our usual motivation of introducing various aspects of mathematical thinking.

In this talk, we will briefly present these two activities. We will then highlight some of the equity considerations which were made in the design process, including the mathematical, cultural and accessibility considerations, especially those which were a consequence of the online format. In particular, we will discuss the challenges in balancing the operational constraints and the equity considerations while maintaining the mathematical value of the activities.

Joint work with Robert Cantwell, Diana Combe, Aditya Ganguly, Amanda Michels, Hanna Nie, Aldhytha Karina Sari and Tom Stindl.

12.2. Update on the peer-mentoring program towards female academic promotion and introduction of the WATTLE program

Birgit Loch (La Trobe University)

Tue 8 December 202014:50

Prof Birgit Loch

In 2016 and 2017 I presented at the AustMS conference about a grassroots peer-mentoring program to assist female academics with their promotion applications. This program commenced at Swinburne University and was then adopted at La Trobe University. I will provide an update on the substantial success these programs have had at both universities in demystifying the promotions process and encouraging female academics to apply for promotion - and getting promoted. I will also introduce WATTLE, the Australian version of NZUWiL, a leadership development program for female academic and professional staff fully owned and run by the so far ten participating universities.

12.3. How WIMSIG can help

Jessica Purcell (Monash University)

Wed 9 December 202013:20

Prof Jessica Purcell

The Women in Mathematics Special Interest Group (WIMSIG) of AustMS was organised in 2013 to support women to achieve their potential in all areas of mathematics, to facilitate the recruitment and retention of women in mathematical careers, and to encourage women to have active careers in the mathematical sciences. In this talk, I will discuss some of the reasons why this is still important, and WIMSIG's ongoing initiatives to achieve this mission.

12.4. Touching and hearing mathematics

Katherine Seaton (La Trobe University)

Tue 8 December 202016:20

Dr Katherine Seaton

This talk will describe the tactile media, recordings, screen-readers, note-takers and other supports that have enabled a visually impaired student to succeed in maths studies at La Trobe. The talk will incorporate my reflections, and his, and describe the benefits to all students of an inclusive classroom.

12.5. Panel discussion: Allyship in Mathematics and Statistics Departments

Aidan Sims (University of Wollongong)

Tue 8 December 202015:20

Prof Aidan Sims

This panel discussion will reflect on what makes a diverse, inclusive and safe mathematical community, and what actions individuals can take to be better allies. The panel is chaired by Aidan Sims, and features a range of people at different stages of career in academia and industry.

13. Mathematical Biology

13.1. Data Driven Model for Detecting Acute and Chronic Insomnia

Maia Nikolova Angelova (Deakin University)

Fri 11 December 202011:00

Maia Angelova, Chandan Karmakar, Ye Zhu, Sergiy Shelyag, Sean Drummond, Jason Ellis

Sleep is essential for human's wellbeing and existence as we spend 1/3 of our lives sleeping. The process of sleep is a complex multi-dimensional cycle that reflects developmental changes in mental and physical health, along with the day-to-day state fluctuations. Insomnia is a serious sleep disorder that remains under-diagnosed. We propose a new data driven model for classification of nocturnal awakenings in acute [1] and chronic insomnia and normal sleep from nocturnal actigraphy collected from pre-medicated individuals with insomnia and normal sleep controls. Our model does not require sleep diaries or any other subjective information from the individuals. We derive dynamical and statistical features from the actigraphy time series data. These features are then combined in data driven model to classify individuals with insomnia from healthy sleepers. The model includes a classifier followed by optimization algorithm that incorporates the predicted quality of each night of sleep for an individual and is able to distinguish iacute/chronic insomnia from healthy sleep. The model provides a robust signature of acute/chronic insomnia obtained from actigraphy only and is very promising as a pre-screening tool to detect the condition in home environment.

M Angelova, C Karmakar, Y Zhu, SP Drummond, J Ellis. (2020). Automated Method for Detecting Acute Insomnia Using Multi-Night Actigraphy Data. IEEE Access, 8, 74413-74422. doi:10.1109/access.2020.2988722

13.2. Cellular navigation in dynamic, noisy environments

Douglas Brumley (The University of Melbourne)

Thu 10 December 202016:00

Dr Douglas Brumley

Ocean nutrient cycling is driven by the concerted action of marine microbes, but the fine-scale interactions between these microbes and their physical and chemical environments remains elusive. I will present recent work which utilises a novel experimental platform for delivering sub-millimetre scale nutrient pulses, quantitatively mimicking those found in the ocean. Advanced video-microscopy is used to characterise microbial motion at the single cell level, and reveals the precise conditions under which bacteria can detect and climb dynamic nutrient gradients. New mathematical theory, based on the counting of individual molecules of dissolved organic matter, is in striking agreement with the experimental findings. From these quantitative foundations, we have developed a mechanistic framework for microbial motion, which directly unifies individual behaviour (cell motility, chemotaxis) with population-scale phenomena (collective nutrient uptake, competition between species). This provides a new path towards predicting ocean carbon cycling which is firmly based on microscale observations.

13.3. To collapse or not to collapse: how do mechanical forces drive vascular regression?

Jessica Crawshaw (The University of Melbourne)

Wed 9 December 202014:20

Ms Jessica Crawshaw

Vascular regression is a critical process concluding the maturation of developing capillary networks, in which redundant blood vessels are removed. Recent research suggests that forces from the local blood flow (haemodynamic forces) trigger polarized endothelial cell migration against the flow, resulting in capillary collapse and regression. However, vascular regression is also driven by several additional pathways including local adhesion forces and cellular signalling factors. Due to the delicate nature of these microvessels, it is difficult to experimentally untangle the roles of each pathway during vascular development. As such, the development of computational models to analyse the relationship between the local haemodynamic forces and the surrounding vasculature during regression are invaluable.

In this talk, we will present a novel computational framework to mathematically study and isolate the role of haemodynamic and adhesive forces in vessel deformation and endothelial cell migration during vascular regression. To model regression, we describe the capillary wall as a discretised hyperelastic membrane, hosting a multicellular model of endothelial cells. The capillary wall and the endothelial cells interact with and respond to the local blood flow in an iterative manner, creating a coupled fluid-structure growth simulation. This discrete approach provides a natural framework to consider the relationship between the capillary wall and the local blood flow and allows for the easy inclusion of structural heterogeneities across the capillary wall. Using this model we are able to examine the relative roles of the haemodynamic forces and the local adhesion forces in vascular regression, and the network level ramifications of local regression.

13.4. A Dynamic Energy Budget model for dung beetles

Alva Curtsdotter (University of New England)

Thu 10 December 202014:30

Dr Alva Curtsdotter

Dung beetles are important ecosystem engineers; through dung burial, they improve pasture quality, soil health, and fly control in Australian pasture lands. As for most insects, there has been little research to predict how climate change may affect these beetles. Dynamic Energy Budget (DEB) theory, and related models, provide a suitable framework for making biologically well-founded predictions of climate change effects on an organism's life history, as the framework describes a single individual's energy allocation to growth, maintenance, and reproduction, as a function of environmental temperature and food availability. However, the first DEB model for insects was only published in 2015, and as of yet, there are no published DEB models for any beetle species. Applying DEB models to dung beetles is therefore far from plug-and-go, and in this talk, I will present work on developing a Dynamic Energy Budget model for dung beetles.

13.5. Mathematical model for the dynamics of vivax malaria infections

Jennifer Flegg (The University of Melbourne)

Wed 9 December 202015:20

Assoc Prof Jennifer Flegg

Malaria is a mosquito-borne disease that, despite intensive control and mitigation initiatives, continues to pose an enormous public health burden. Plasmodium vivax is the most geographically widespread species of malaria. Relapsing infections, caused by the activation of liver-stage parasites known as hypnozoites, are a critical feature of the epidemiology of Plasmodium vivax. Hypnozoites remain dormant in the liver for weeks or months after inoculation, but cause relapsing infections upon activation.

In this talk, I will introduce a dynamic probability model of the activation-clearance process governing both potential relapses and the size of the hypnozoite reservoir, deriving analytic expressions for the time to first relapse and the time to hypnozoite clearance for mosquito bites establishing variable numbers of hypnozoites, both of which are quantities of epidemiological significance. The within-host model can be embedded readily in multiscale models and epidemiological frameworks, with analytic solutions increasing the tractability of statistical inference and analysis. The work therefore provides a foundation for further work on immune development and epidemiological-scale analysis, both of which are important for achieving the goal of malaria elimination.

13.6. The case for normal phylogenetic networks

Andrew Francis (Western Sydney University)

Wed 9 December 202015:50
Prof Andrew Francis

Numerous classes of phylogenetic network have been defined and studied, with the goal of making the inference of complex evolutionary relationships a reality. In this talk I will present a case for why the class of "normal" networks has emerged as the most promising of these.

13.7. Hungry, hungry hoppers: investigating the interaction of food distribution and gregarisation on the formation of locust hopper bands

Fillipe Harry Georgiou (The University of Newcastle)

Tue 8 December 202016:20
Mr Fillipe Harry Georgiou

Locust swarms are a major threat to agriculture, affecting every continent except Antarctica and impacting the lives of 1 in 10 people. Locusts are short horned grasshoppers that exhibit two behaviour types depending on their local population density. These are; solitarious, where they will actively avoid other locusts, and gregarious where they will seek them out. It is in this gregarious state that locusts can form massive and destructive flying swarms or plagues. However, these swarms are usually preceded by the formation of hopper bands by the juvenile wingless locust nymphs. It is thus important to understand the hopper band formation process to control locust outbreaks.

In this talk I present a model of locust foraging and investigate the effect of food on both the formation and characteristics of locust hopper bands as well as showing a possible evolutionary explanation for gregarisation in this context.

13.8. The impact of SARS-CoV-2 viral dynamics on population level spread, super-spreader events, and optimization of masking and antiviral therapy

ASHISH GOYAL (Fred Hutchinson Cancer Research Center)

Fri 11 December 202010:30
Dr Ashish Goyal

Approximately 10 months into the pandemic, the world is still struggling to contain the spread of SARS-CoV-2 and to limit the severity of cases. More than 35 million cases and over 1 million deaths have occurred globally with continued severe impact on the world economy. In this talk, I will describe mathematical models based on the observed viral shedding patterns of infected people. These models are intended to optimize prevention and treatment strategies for the virus. I will demonstrate that targeting super-spreader events would have a disproportionate impact on lowering cases, that slight increases in mask uptake or efficacy would curb exponential growth of cases, and that early treatment is vital to successful treatment of the virus.

13.9. The interplay of feedback and buffering in cellular homeostasis

Edward Hancock (The University of Sydney)

Thu 10 December 202016:30
Dr Edward Hancock

Determining the underlying principles behind biomolecular regulation is important for understanding the principles of life, treating complex diseases, and creating de-novo synthetic biology. Buffering - reservoirs or molecules used to maintain molecular concentrations - and feedback are two ubiquitous methods of regulation in cellular biology. For example, during exercise energy is initially supplied from a buffer (phosphocreatine) before feedback increases the energy supplied by anaerobic metabolism. However, while feedback has received extensive theoretical study, there has been considerably less attention to buffering and its interactions with feedback. Here, we present work on the interplay between buffering and feedback in cellular homeostasis. We show that the synergy between the two is often critical for regulation: feedback regulates 'slow' disturbances while buffering regulates 'fast' disturbances and can stabilise unwanted oscillations due to feedback. Further, buffering can enable the simultaneous, independent control of multiple outputs. We highlight the applications of the work with examples in metabolism and synthetic biology.

13.10. Quantitative modelling distinguishes severity in the immune response to SARS-CoV-2

Adrianne Jenner (Queensland University of Technology)

Wed 9 December 202012:50

Adrianne L. Jenner, Rosemary Aogo, Paul Macklin, Penelope A. Morel, Courtney L. Davis, Amber M. Smith, Morgan Craig,

The primary distinction between severe and mild COVID-19 infections is the immune response. Disease severity and fatality has been observed to correlate with lymphopenia (low blood lymphocyte count) and increased levels of inflammatory cytokines and IL-6 (cytokine storm), damaging dysregulated macrophage responses, and T cell exhaustion due to limited recruitment. The exact mechanism driving the dynamics that ultimately result in severe COVID-19 manifestation remain unclear. To delineate mechanisms regulating differential immune responses to SARS-CoV-2, we have developed tissue- and systemic-level models of the immune response to infection with the goal of pinpointing what may be causing dysregulated immune dynamics in severe cases. At the tissue level, we been working as part of the international SARS-CoV-2 Tissue Simulation Coalition (physicell.org/covid19) to build a computational framework to study SARS-CoV-2 in the tissues based on an open-source computational cell-based software that combines an agent-based modelling framework with partial differential equation diffusion models. In parallel, we constructed a systemic, within-host mechanistic (DDE) mathematical model linking viral kinetics to the innate and adaptive immune response. This model accounts for the interactions between viral load, viral strain, infected and damaged epithelial tissue cells in the lungs, immune cell subsets (primarily tissue-resident and inflammatory macrophages, CD8 T cells, monocytes, and neutrophils), and inflammatory cytokines (i.e. IFN-1, GM-CSF, G-CSF, IL-6), and recapitulates mild and severe COVID-19 presentations. Through the expansion of virtual patient cohorts, we analyzed the mechanisms regulating the diversity of immune responses to SARS-CoV-2 to identify those that predispose individuals to particularly to severe disease. Together, these platforms represent a comprehensive framework that will improve our understanding of SARS-CoV-2 infection dynamics and immune response.

13.11. Effects of environmental heterogeneity on species spreading with free boundary reaction diffusion models

Kamruzzaman Khan (University of New England)

Thu 10 December 202013:30

Kamruzzaman Khan, Timothy M. Schaerf, and Yihong Du

This work investigates the effect of environmental heterogeneity on species spreading. The analysis is based on numerical simulation of suitable reaction-diffusion models, and we focus on the changes of long-time dynamics and spreading speeds of the species as the parameters describing the heterogeneity of the environment are varied. Firstly a single species model is examined; the model is a variation of the Fisher model in that the population range is always assumed to be a finite one dimensional interval evolving with time, whose boundaries are treated as free boundaries. Such a model in time-periodic environment and in space-periodic environment has been theoretically treated by Du et. al. (2013), Du and Lin (2010), but more detailed properties are obtained here through numerical analysis. The biological interpretations of our results on the spreading speed, in the space-periodic case, mostly agree with those of Kinezaki, Kawasaki and Shigesada (2006), but some differences exist. Secondly, we numerically examine a two species version of the single species free boundary model, which was treated by Du and Wu (2018); Guo and Wu (2014), and Khan et. al. (2020)recently. This is a two species competition system describing the dynamics of two competing species u and v invading the environment simultaneously. The previous works mostly concentrate on the case of homogeneous environment, although the time-periodic case was touched in Khan et. al. (2020) via numerical analysis - the other two works are theoretical. The numerical analysis in Khan et. al. (2020) indicates that the long-time dynamics of the model (in a homogeneous environment) exhibits only four types of behaviour. Our analysis here shows that these four types of long-time dynamical behaviour are robust: they are retained under time-periodic as well as space-periodic perturbations of the environment. By varying the parameters in the time-periodic and space-periodic terms of the model, we have numerically examined their influence on the long-time dynamics and on the spreading speeds of the two species. Generally speaking, our results suggest that heterogeneity of the environment enhances the invasion of the two species, although there are subtle differences of the influences felt by the two.

13.12. How does the evolution of monogamy depend on human life history?

Viney Kumar (The University of Sydney)

Thu 10 December 202014:00

Mr Viney Kumar

The human species is unique among other great apes in its tendency towards pair bonding. Traditional explanations for this evolution have focused on the presence of paternal care and the needs of our offspring. However, recent research has challenged this claim, contending that the significant effects of mating competition on male choice result in an evolutionary equilibria with little male care. In this talk, we model the dynamics of a two-sex population and determine conditions for pair bonding (or social monogamy) to supersede multiple mating as the optimal allocation of male reproductive effort. Using a system of ordinary differential equations, we determine the evolution of mating strategies under varying life history parameters, such as interbirth interval, age of menopause, and longevity. Our results show that a slower rate of mating combined with shorter female fertility due to menopause and child mortality provides a sufficient evolutionary bias to enable pair bonding to dominate over multiple mating. On the other hand, the effect of varying the interbirth interval is more complex, and it suggests that the prevailing anthropological explanations for the evolution of pair bonding are more nuanced than previously thought.

13.13. The Evolution of Menopause

Anthia Le (The University of Queensland)

Wed 9 December 202016:50

Miss Anthia Le

When we examine the life history of humans against our close primate relatives, the great apes, we see that human adult lifespans include a post-menopausal life stage. This led to the question, "how did human females evolve to have old-age infertility?"

Morton et al. suggested that ancestral male mating choices, particularly forgoing mating with older females, was the driving force behind the evolution of menopause. As their agent-based model is difficult to analyse, we propose an analogous system of ordinary differential equations (ODE) to examine their conclusions. Our conclusions contradict that of Morton et al., as we find that even the slightest deviation from an exclusive mating preference for younger females would counteract the evolution of menopause.

13.14. Mammalian Oocyte Fertilisation Waves

Thomas Miller (University of South Australia)

Tue 8 December 202015:20

Mr Thomas Miller

Before fertilisation a mammalian oocyte is surrounded by cumulus cells that are essential to its survival. After fertilisation the cumulus cells are no longer required and they die. An experiment carried out using bovine eggs observed a calcium wave that coincided with the cumulus cell death, however it is not known if the calcium wave is the cause, or just a by-product, of the process. In this talk, I'll describe a non-linear reaction-diffusion model for these waves based on one previously used for calcium fertilisation waves on the surface of amphibian eggs. Exact analytical solutions are constructed using nonclassical Lie symmetry analysis, and these solutions are qualitatively compared to experiment.

13.15. Systematic analysis of a hybrid zonal model

Rajnesh Krishnan Mudaliar (University of New England)

Wed 9 December 202013:20

R.K. Mudaliar and T.M. Schaerf

Groups of animals display eye catching collective movements in nature. Some examples are starling murmuration over the roost at dusk, toroidal milling of fish under water, swarms of insects, trails of foraging ants and herds of mammals. It is thought that these patterns emerge due to repeated interactions between group members at scales smaller than that of the group; these interactions are sometimes referred to as "rules of interaction". Such rules of interaction include: *repulsion*: individuals adjust their velocity to avoid collision with near neighbours; *orientation*: individuals adjust their velocity to match that of neighbours that are nearby (but not close enough to crash into); and *attraction*: to avoid group fragmentation, individuals adjust their velocity to move towards far group members. Many collective motion models apply such rules based on the metric distance between the groupmates (that is, standard linear distances).

An important study on natural flocks of European starlings (Ballerini et al. (2008) PNAS 105(4):1232-1237) found evidence that suggests that interactions in such flocks depend on topological distances between neighbours (that is interactions with n nearest neighbours), and are limited to interactions with a small number of nearest neighbours (perhaps 6 to 7). Such an observation makes most sense in terms of orientation- and attraction-type rules of interaction, which could apply over any length scale within the visual range of an individual, but less sense in terms of collision avoidance (repulsion) interactions, which are most important when neighbours are nearby in a metric distance sense.

In this study, we modify an important metric scale zonal model (described in Couzin et al. (2002) JTB 281(1):1-11) such that collision avoidance (repulsion) is moderated over linear distances, but orientation and attraction behaviours apply to fixed numbers of neighbours outside the collision avoidance/repulsion zone. Similar to the original zonal modal in Couzin et al. (2002), the number of interacting indiviudals in the orientation and attraction zones can be varied to produce computer simulations of swarms, fragmented groups and parallel aligned groups. We systematically examine the emergent states of our hybrid zonal model, taking into account group fragmentation and sensitivity of our analysis to the threshold used to identify such fragmentation.

From our analysis of emergent states we observe that the emergent mill pattern is very rare. Groups fragmented when individuals applied orientation and attraction interactions with few neighbours, swarmed when individuals oriented with relatively few neighbours and were attracted to a greater number of neighbours, and formed parallel groups when orientation interactions were applied to many partners.

13.16. Structured Population Models for Macrophages in Atherosclerotic Plaques

Mary Myerscough (The University of Sydney)

Tue 8 December 202014:50

Prof Mary Myerscough

Macrophages are typical cells that participate in many types of chronic and acute inflammation. In this talk we consider populations of macrophages that are found in atherosclerotic plaques where they may contribute either to plaque growth or to plaque resolution. Macrophages in plaques accumulate internalised lipids, such as cholesterol, both through ingesting modified low density lipoprotein particles (modLDL) and through ingesting other macrophages that have undergone apoptosis (programmed cell death). In this way macrophages may accumulate enough internalised lipid that they take on a foamy appearance under the microscope and are known as foam cells.

We present an advective PDE model for the populations of macrophages and apoptotic cells, structured by their internalised lipid content. We find steady state solutions analytically and use this model to explore the factors that contribute to plaque progression and regression. The model shows impressive agreement with *in vitro* experiments in the case when lipid accumulation is due to ingestion of apoptotic cells only. We extend the model to the case where macrophage behaviour depends on the accumulated internalised lipid that each macrophage contains. We show that in certain circumstances, macrophage proliferation may reduce the average internalised lipid load in the model plaque and lead to reduced plaque growth.

The results of this research suggest that tracking lipids, both in cell membranes and in modLDL is just as important as tracking macrophage numbers in modelling atherosclerotic plaque development.

13.17. Local interactions in the collective motion of Antarctic krill

Timothy Schaerf (University of New England)

Thu 10 December 202013:00

Alicia Burns, Timothy Schaerf, Joseph Lizier, So Kawaguchi, Martin Cox, Rob King, Jens Krause, Ashley Ward

Antarctic krill (*Euphausia superba*) are one of the most abundant and important animal species and are often described as the keystone species of the Southern Ocean, a species of such vital importance that if they were removed an entire ecosystem could collapse. During their lifetime these krill can form vast swarms, which confer potential safety in numbers, enhanced ability to track nutrient gradients, and improved energy efficiency while swimming.

The broad theory that underpins modern studies of collective motion is that group-level patterns of movement across many species arise due to the application of local rules of interaction that describe how individuals adjust their velocity in response to the relative positions and behaviours of their group mates. There are now several viable methods for trying to infer such interaction rules from experimentally derived trajectory data, including the simplest force-matching/averaging methods, machine learning based methods, and more complex statistical schemes.

This presentation will cover recent work aimed at better understanding krill swarming via the analysis of trajectory data using a force-matching/averaging method. We filmed the movements of relatively small groups of free-swimming Antarctic krill in aquaria at the Australian Antarctic Division in Kingston, Tasmania, using stereo-video cameras. The movements of individual krill were then tracked manually (in two spatial dimensions), with the identities of krill resolved across paired images from the stereo cameras, before projective geometry was applied to reconstruct the trajectories of the krill in three-dimensions. We then applied an averaging/force-matching method to examine the average changes in the components of the krill's velocity as a function of the relative coordinates of neighbours, in a consistent frame of reference with respect to gravity and the velocity of individual krill. When applied to the krill, the averaging method reveals a clear, but complex pattern of turning and moderation of speed in response to the relative positions of neighbours. These patterns suggest the presence of social interactions being applied by krill when adjusting their velocity, but differ markedly in detail to the sorts of rules applied in a general individual based model for collective movement. In particular, the krill that we observed tended to slow down when their partners were "above" (in the relative coordinate system), or directly below, but increased speed when partners were to their front or rear. The krill also tended to turn in some form to avoid their neighbours, except those located below and to their front. This study represents an important step in better understanding the social elements that may contribute to the movement of krill swarms, and developing better informed models of these swarms.

13.18. Global Stability and Periodicity in a Glucose-Insulin Regulation Model with a Single Delay

Sergiy Shelyag (Deakin University)

Fri 11 December 202011:30

M. Angelova, G. Beliakov, A. Ivanov, and S. Shelyag

A system of two delay-differential equations describing the glucose-insulin interaction processes in the human body is considered. Sufficient conditions are derived for the unique positive equilibrium in the system to be globally asymptotically stable. The conditions are given in terms of the global attractivity of the fixed point in a limiting interval map. The existence of slowly oscillating periodic solutions is shown in the case when the equilibrium is unstable. The mathematical results are supported by extensive numerical simulations. It is shown that typical behaviour in the system is the convergence to either a stable periodic solution or to the unique stable equilibrium. The coexistence of several periodic solutions together with the stable equilibrium is demonstrated as a possibility.

13.19. The Shape of Phylogenies Under Phase–Type Distributed Times to Speciation and Extinction

Albert Christian Soewongsono (University of Tasmania)

Tue 8 December 202015:50

Mr Albert Christian Soewongsono;Prof. Barbara Holland;A/Prof. Małgorzata O'Reilly

We consider a macroevolutionary model for phylogenetic trees where times to speciation or extinction events are drawn from a Coxian phase-type (PH) distribution. We show that different choices of parameters in our model lead to a range of tree shapes as measured by Aldous' β statistic. In particular, it is possible to find parameters that correspond well to empirical tree shapes. We also provide a natural extension of the β statistic to sets of trees. This extension produces less biased estimates of β compared to using the median β values from individual trees. Lastly, we derive a likelihood expression for the probability of observing any edge-weighted tree under a model with speciation but no extinction. We perform goodness-of-fit tests for two large empirical phylogenies (squamates and angiosperms) that compare models with Coxian PH distributed times to speciation with models that assume exponential or Weibull distributed waiting times. We found that, in many cases, models assuming a Coxian PH distribution provided the best fit.

Key words: Macro-evolutionary model; diversification; stochastic model; tree shape; phase-type distribution.

13.20. Modelling heterogeneous risk of malaria relapses in multiple recurrence data from a cohort study in Southeast Asia

Eva Stadler (UNSW Sydney)

Fri 11 December 202010:00

Eva Stadler, David Khoury, Timothy Schlub, Adeshina I. Adekunle, Deborah Cromer, Miles Davenport

One species of malaria (Plasmodium vivax) is known to cause malaria infections even after people are treated with antimalarial drugs. This is due to dormant and undetectable parasites in the liver which periodically activate and initiate new infections. These infections are called relapses and account for the majority of malaria cases in some regions whereas new infections (i.e., new bites from an infected mosquito which transmits the parasite) only account for a small fraction of malaria cases. Despite the important role of relapses in malaria epidemiology, few models of malaria relapse have been constructed and the pattern of malaria relapse timing has only been explored with relatively simple models, such as those that assume constant risk of relapse for all people over all time. Clear evidence exists that relapse risk is not constant and may vary in time and across the population. Here we construct models of relapse risk that include temporal and population heterogeneity and find that population heterogeneity is a major factor underpinning the relapse patterns of a cohort of 1299 people from the Thailand-Myanmar border region. Furthermore, simulations show that population heterogeneity in the risk of relapse can be leveraged for more effective treatment strategies.

13.21. Circular Genome Rearrangements and the Hyperoctahedral Group

Joshua Stevenson (University of Tasmania)

Wed 9 December 202013:50

Mr Joshua Stevenson

In the context of estimating genome rearrangement distances, genomes are often represented by signed permutations. These permutations form the Hyperoctahedral group. I will discuss this connection and describe some other key ideas from genome rearrangement modelling from an algebraic perspective.

13.22. Irreducible semigroup-based Markov models

Venta Terauds (University of Tasmania)

Fri 11 December 202012:00

Dr Venta Terauds

We present a complete characterisation of irreducible semigroup-based Markov models. Semigroup-based Markov models, introduced by Sumner and Woodhams in 2019, are a generalisation of group-based models. They possess many of the pleasing properties of group-based models, with notable examples including the Felsenstein 81 model.

13.23. Analysis of Collective States and Their Transitions in Football

Mitchell Welch (University of New England)

Thu 10 December 202015:30

Dr Mitchell Welch

Movement, positioning and coordination of player formations is a key aspect for the performance of teams within field-based sports. The increased availability of player tracking data has given rise to numerous studies that focus on the relationship between simple descriptive statistics surrounding team formation and performance. While these existing approaches have provided a high-level a view of team-based spatial formations, there has been limited research on the nature of collective movement across players within teams and the establishment of stable collective states within gameplay. This study draws inspiration from the analysis of collective movement in nature, such as that observed within schools of fish and flocking birds, to explore the existence of collective states within the phases of play in soccer. The results from this study demonstrate that sequences of ordered collective behaviours exist with relatively rapid transitions between highly aligned polar and un-ordered swarm behaviours (and vice-versa). Defensive phases of play have a higher proportion of ordered team movement than attacking phases, indicating that movements linked with attacking tactics, such as player dispersion to generate passing and shooting opportunities lead to lower overall collective order. Exploration within this study suggests that defensive tactics, such as reducing the depth or width to close passing opportunities allow for higher team movement speeds correlated with increased levels of collective order. This study provides a novel view of player movement by visualising the collective states present across the phases of play in soccer.

13.24. Bridging Agent-Based Modelling with Equation-Based Modelling of COVID-19 pandemic in New South Wales.

Zhao Mei Zheng (The University of Sydney)

Wed 9 December 202016:20

Miss Zhao Mei Zheng

In response to the sudden COVID-19 pandemic, various models of varying complexity have been produced to inform public health policies. These models range from high-level, fine-grained agent-based model (ABM) simulations of individuals, such as the University of Sydney Complex Group's Australian Census-based Epidemic Model (ACEMod), which are computationally difficult to simulate, to broad differential equations assuming homogeneous mixing within a population. It is an open problem whether certain key dynamics of the epidemiological component of ACEMod developed and calibrated specially to COVID-19, AMTraC-19, can be effectively captured with an equation-based model (EBM) such as a system of ordinary differential equations.

In this project, we develop a simplified ABM of the COVID-19 pandemic for NSW and methodically derive an ordinary differential EBM to unveil the direct links between these two distinct approaches. These models capture a day-night cycle mixing dynamic across different geographic regions of NSW which include mobility and human interactions derived from 2016 Australian census data. Other key model parameters mainly follow AMTraC-19's calibrated COVID-19 values. We examine the effect of various intervention strategies including differing levels of social distancing on reducing infection cases in both models and evaluate their efficacy.

These derivation methods to convert an ABM to an EBM can be applied to other agent-based computations to help further analyse the effectiveness of public health policies and also further general public understanding of disease dynamics at a lower computational cost. These flexible and reliable EBMs can also be used to evaluate further possible improvements of intervention strategies in mobility and social distancing policies to reduce infection cases.

14. Mathematics Education

14.1. Forum: Online delivery and assessment under Covid-19 conditions

John Banks (The University of Melbourne)

Thu 10 December 202013:30

Dr John Banks

This has been an unprecedented year for the entire world - no less so for university level teachers of mathematics and statistics. The challenges commenced with a rapid switch to online delivery, progressed to maintaining teaching quality under radically changed circumstances and drifted into the challenge of preserving assessment integrity in subject that have traditionally relied heavily on final examinations. This forum is not intended as a traditional academic talk focussed on a particular program or topic, but rather a series of short presentations on the approaches people have adopted during the current crisis and a chance to present any evidence on the effectiveness of these approaches.

14.2. MathAssess - a system for creating and delivering formative mathematical assessments

Dmitry Demskoi (Charles Sturt University)

Thu 10 December 202016:30

Dr Dmitry Demskoi

We describe a new system for creating and delivering formative mathematical assessments (MathAssess). MathAssess is a free and extensible system which allows instructors to write questions and conduct marking using the Maple language. MathAssess builds on our previous work devoted to a method of creating offline assessments based on the PDF format as a means of delivery and Maple as a supporting computer algebra [K. Cullis, D. K. Demskoy, K. Herbert. Creating mathematics formative assessments using LaTeX, PDF forms and computer algebra. *Australasian Journal of Educational Technology*, 35(5) (2019), 153-167]. The new system retains reliance on Maple as a computational engine, but moves delivery component onto the web.

MathAssess is a system with separate question design and answer collection: the processes of editing individual questions, their assembly into an assessment, and marking is completed on instructor's computer using computer algebra (Maple). Assessment questions are written using a combination of html/LaTeX/Maple code. Completion and submission of an assessment is done online on MathAssess website. All submitted answers are stored in an online database. MathAssess may be set up so that students can come back and see/modify submitted tests as long as it is done before assessment's due date/time.

14.3. Igo Math - Smuggling more Mathematics into the Liberal Arts curriculum with the help of the ancient game of Go

Attila Egri-Nagy (Akita International University)

Tue 8 December 202016:20

Dr Attila Egri-Nagy

The historical AlphaGo vs. Lee Sedol match in 2016 sparked new interests in the game of Go. The advances in artificial intelligence also created an opportunity for designing an integrated AI/Mathematics course. This presentation will review the motivations and design decisions and then evaluate the course's performance after three semesters.

Information about the course: https://egri-nagy.github.io/igomath/

14.4. The benefits of online formative assessment for tertiary mathematics students

Mary Ruth Freislich (University of New South Wales)

Thu 10 December 202013:00

Mary Ruth Freislich, University of New South Wales Sydney, Alan Bowen-James, Le Cordon Bleu Australia Business School

The present study continues previous work by the same authors. Both the present and the previous work investigate the effect of a change to using more formative assessment in the first of the core mathematics subjects taken by large first-year enrolment groups in a large Australian university. The first-year mathematics subjects that are needed by engineering and science students who continue to more advanced mathematics in later years were taught at two levels, Ordinary and Higher, with the Higher version taught at a slightly more advanced level. The change in teaching delivery was implemented in the same way for both levels. It involved no changes in syllabus, total teaching hours or materials. Class tests during the teaching period were changed by giving Cohort 2 unlimited practice and computer assisted feedback on questions in the test database, followed by doing the tests under examination conditions. A written assignment was also introduced, focused on clarity of writing and supplying appropriate evidence in the solution of a mathematical problem. Learning outcomes for the two cohorts at the Ordinary level were compared in the previous study, using closely comparable tasks from the final examinations, and comparing cohorts using a method derived from the SOLO taxonomy to provide a common scale for the comparison. Results strongly favoured Cohort 2, with statistical significance supported by non-trivial effect sizes. The present work used a similar method to compare the two more highly selected cohorts doing the Higher subject, and found very similar results. It follows that the change to more formative assessment functioned as intended, to promote learning with understanding for the better prepared and committed Higher group.

14.5. The Non-Technical Skills Employers Want

Joanne Hall (Royal Melbourne Institute of Technology)

Thu 10 December 202016:00

Dr Joanne Hall

There is research on the non-technical skills needed in ICT and engineering, but little in an Australian context. To support the job readiness of graduates it is necessary to identify the non-technical skills that are needed to be competitive in the modern job market.

Through surveys an interviews we gathered data on the non-technical skills most valued by employers of recent graduates in cybersecurity roles. We report on the most frequently sought after non-technical skills. A brief analysis indicates that some of the most sought after non-technical skills are neither explicitly taught nor explicitly assessed in many degrees in Australia.

Joint work with Prof. Asha Rao

14.6. Online delivery of first year maths: challenges and opportunities

Poh Hillock (The University of Queensland)

Thu 10 December 202015:30

Dr Poh Hillock

In March 2020, The University of Queensland (UQ) moved all teaching activities online in response to the COVID-19 pandemic. Staff had a week to prepare their courses for online delivery. This presentation describes the transformation of a large first year mathematics course to the online mode. We discuss the unique challenges and learning opportunities experienced by students, the majority of whom were in their first semester of university studies.

14.7. Comparing mathematics and statistics support BC (before COVID) and DC (during COVID)

Deborah Jackson (La Trobe University)

Tue 8 December 202015:20

Dr Deborah Jackson

Quality mathematics and statistics support is becoming increasingly important, particularly now that learning has become predominantly an online activity. Support centres provide a place for students to gain confidence, ask questions, and discuss problems. Active communication in this way is often key to a student's success. For support to be truly successful, however, it must also be relevant, engaging, convenient, and targeted, and a place where the underlying reasons for misunderstandings are addressed. This presentation discusses the transition of La Trobe's Maths Hub support centre into fully online activities and sessions, with face-to-face in a room becoming face-to-face via zoom. The impact of COVID-19 upon the delivery of support is discussed, and how well students and tutors adjusted to the changes. A comparison of 2019 BC (before COVID) with 2020 DC (during COVID) is presented with stunning results. They show Maths Hub support has not only sustained its usefulness and positive impact on students, but module engagement (self-paced worksheets and quizzes) has substantially increased.

14.8. Learning progressions for mathematics

Terence Mills (La Trobe University)

Tue 8 December 202015:50

Terence Mills and Kathryn Richardson

In 2017, the Australian Government established a national review of schooling to investigate how to improve student achievement and school performance. The final report, known colloquially as Gonski2, placed a considerable emphasis on growth in a student's learning. The report recommended that educators should aspire to "[d]eliver at least one year's growth in learning for every student every year" (Department of Education and Training, 2018, p. 6).

. The report proposes that "learning progressions" are the key to measuring growth in learning. We see their impact on the recent review of the NSW school curriculum (see Masters, 2020, p. 52). While learning progressions offer a new perspective on teaching, learning, and assessment, access to empirically derived learning progressions, particularly outside traditional numeracy and literacy domains, is scarce. The papers in Siemon, Barkatsas, & Seah (2019) offer a useful introduction to the literature.

. Although most of the public debate about learning progressions is focussed on schools, it behoves university mathematicians to be aware of these developments because we all share an interest in the Australian education system, especially with respect to the teaching and learning of mathematics. Moreover, consideration of learning and how it progresses should inform learning, teaching and assessment at all levels of education, including tertiary. This leads to the question: How can growth in mathematics learning be measured and monitored?

. The purpose of this paper is to investigate the concept of learning progressions and how they apply within learning and teaching environments. Specifically, how might a mathematics learning progression be designed by educators? This paper critically evaluates the advantages and disadvantages of developing and using learning progressions to guide learning, teaching and assessment within the mathematics domain. Illustrative examples that utilise existing taxonomies of learning are provided within the context of secondary school mathematics in Australia.

. We thank Andrew Grichting for helpful discussions.

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14.9. Engagement in a large first-year engineering maths unit during lockdown

Anja Slim (Monash University)

Thu 10 December 202015:00

Dr Anja Slim

I will describe my experiences restructuring a large first-year engineering maths unit for the second Melbourne lockdown, with an emphasis on developing and maintaining a sense of community online. Specifically I will describe using Moodle ”lessons” for flipping the classroom, using group quizzes during tutorials and introducing group assignments. The unit achieved significantly higher student engagement than in previous years and student feedback was positive. I will focus particularly on the benefits and challenges of running group assignments and their potential in a non-lockdown environment.

14.10. Community in the Classroom: Practical strategies to foster students' sense of belonging in mathematics

Chris Tisdell (University of New South Wales)

Tue 8 December 202014:50

Holly McCarthy, Rachel Abel and Chris Tisdell

“Loneliness, defined as a subjective experience of social isolation, has been identified as the next public health epidemic of the 21st century” (Lim, 2018). Given this, and the impact of COVID-19, advancing our understanding of belonging and community within the context of higher education forms a critical and timely challenge.

Mounting evidence points to student belonging as a foundation of engaged learning, persistence to graduation and student wellbeing (Schreiner, 2010; Hoffman et al, 2002; Freeman et al, 2007). However, understanding how to foster a sense of belonging to a community remains elusive as there is an absence of scholarly literature pointing to the practical activities and approaches that can be applied to develop inclusion and a sense of close connection between students and their learning communities.

We aim to explore this gap in the literature and establish a foundation for future research into practical methods for fostering students' sense of belonging to a learning community within mathematics classrooms.

As part of a quasi-experimental design, informal pedagogical interventions were delivered in tutorial and lecture settings to build relationships and foster students' sense of membership, partnership and ownership within a learning community - an undergraduate maths course of 381 local and international students. Our mixed method approach captured quantitative and qualitative data relating to students' experiences of interventions and their sense of belonging to the learning community.

Our results indicate that there are practical activities and approaches that teachers can incorporate to give students a sense of feeling included or believing they are closely connected to the learning community, such as those centered around flexibility, friendliness, interactivity, encouragement, and support.

Our work supports the position that students' sense of belonging can be enhanced by structures and activities in the classroom as well as approaches that draw on teacher-led pedagogy. Furthermore, instilling in teaching staff an awareness of the importance of cultivating community and enacting pedagogical warmth is also impactful and can lay the necessary foundation for more specific interventions.

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15. Mathematical Physics, Statistical Mechanics and Integrable systems

15.1. Modularity in Logarithmic Conformal Field Theories

Zachary Fehily (The University of Melbourne)

Wed 9 December 202012:50

Mr Zachary Fehily

Logarithmic conformal field theories are increasingly playing a role in applications of CFTs to physics. Such applications include percolation, quantum Hall transitions, 4d-2d duality and string theory. By virtue of being logarithmic, many of the familiar tricks and tools used for computations in rational CFTs no longer apply in a straightforward way. In particular, a systematic approach to computing modular transformations and fusion rules of such theories has not been found except for some specific cases. In this talk, I will describe how the standard module formalism, introduced by Creutzig and Ridout in terms of representations of the underlying vertex operator algebra, solves this problem for the c=2 beta-gamma ghost system, admissible-level sl(2) theories and my recent progress in applying this formalism to admissible-level Bershadsky-Polyakov algebras. Connections between these theories and potential extensions will be briefly explained.

15.2. Recent advances for integrable long-range spin chains

Jules Lamers (The University of Melbourne)

Wed 9 December 202016:50

Dr Jules Lamers

I will introduce quantum-integrable long-range spin chains and report on recent progress in the field. The exact solvability/integrability of these models has a different flavour than for the nearest-neighbour Heisenberg spin chains. For the Haldane–Shastry spin chains this exploits a connection with affine Hecke algebras, which in particular provide Yangian or quantum-loop symmetries via the Drinfel'd and Chari–Pressley functors. The exact solution of the Inozemtsev spin chain relies on a connection with a special case of the elliptic quantum Calogero–Sutherland model; here the underlying quantum-integrable structure is not known yet. My talk is based on joint work with R. Klabbers (Nordita), with V. Pasquier and D. Serban (IPhT CEA/Saclay), and work in progress.

15.3. Painlevé transcendents in quantum mechanics and related algebraic structures

Ian Marquette (University of Queensland)

Wed 9 December 202015:20

Dr Ian Marquette

I will discuss the six Painlevé transcendents which were obtained by Painlevé, Gambier and Fuchs in early 1900. They play an important role in classification of ordinary differential equations and they were related to several contexts such as reduction of various nonlinear differential equations of mathematical physics, relativity, statistical mechanics, and field theory. Their connection with non-relativistic quantum mechanics is much more recent.

I will review the classification of quantum superintegrable systems on two-dimensional Euclidean space with a second and an extra integral of higher order ($N > 2$) and in particular N=3,4. Their integrals generate finitely generated polynomial algebras and their representations can be exploited to calculate the energy spectrum. More recently, a method has been developed for the analysis and classification of higher order superintegrable systems on any 2D Riemannian space. New models with the sixth and fifth Painlevé transcendents on 2-sphere and 2-hyperboloid have been obtained. I will complete this review by discussing recent work on how these Painlevé transcendents are in fact connected with with one dimensional quantum Hamiltonians with operator algebras of Abelian, Heisenberg, Conformal and ladder type. I will point out how the classification of all these models is connected to the classification of Chazy type of equations.

I will also briefly discuss recent results on the quantum superintegrable models with the sixth Painlevé transcendent in the case of rational solutions which relates to the exceptional orthogonal polynomial of Jacobi and how the spectrum can be obtained via only algebraic manipulations.

15.4. Symmetry-protected topological phases beyond groups: The q-deformed bilinear-biquadratic spin chain

Thomas Quella (The University of Melbourne)

Wed 9 December 202014:20

Dr Thomas Quella

We analyze the phase diagram of the quantum group invariant spin-1 bilinear-biquadratic spin chain. Even though it fails to exhibit any of the standard symmetries known to protect the Haldane phase it still displays all characteristics of this symmetry-protected topological phase in part of the phase diagram: Fractionalized spin-12 boundary spins, non-trivial string order and - when using an appropriate definition - a two-fold degeneracy in the entanglement spectrum. We trace these properties back to the existence of an SOq(3) quantum group symmetry and speculate about potential links to discrete duality symmetries. We expect our findings and methods to be relevant for the identification, characterization and classification of other symmetry-protected topological phases with non-standard symmetries.

15.5. Coloring K-Theoretic Schubert Calculus With Lattice Models

Travis Scrimshaw (The University of Queensland)

Wed 9 December 202016:20

Dr Travis Scrimshaw

Double Grothendieck polynomials were introduced as polynomial representatives of Schubert varieties in the equivariant K-theory ring of the full flag variety. Recently, a combinatorial formula using bumpless pipe dreams of Lam-Lee-Shimozono was proven by Weigandt using a formula due to Lascoux that describes double Grothendieck polynomials using alternating sign matrices. In this talk, we will give another proof of this formula by translating bumpless pipe dreams into the language of colored integrable vertex models. We then show the generating function (aka the partition function) of our colored lattice model satisfies the same functional relations as double Grothendiecks up to a known factor by using the Yang-Baxter equation. By exploiting a natural duality, we use our vertex model to give a new proof that double Grothendieck polynomials for vexillary permutations are flagged Grothenieck polynomials and that the stable limit is a factorial Grothendieck polynomial. This is joint work with Valentin Buciumas.

15.6. Emergence of envelop solitary waves from the localised pulses within the Ostrovsky equation

Yury Stepanyants (University of Southern Queensland)

Wed 9 December 202013:20

Roger Grimshaw and Yury Stepanyants

We study the emergence of envelope solitons from the Korteweg-de Vries (KdV) solitons in the longterm evolution within the framework of the Ostrovsky equation. This equation was derived by L.A. Ostrovsky in 1978 for the description of weakly nonlinear oceanic waves affected by the Earth' rotation. Subsequently, it became clear that this equation is rather universal and it is widely used for the description of nonlinear waves in various media. In applications to the media with negative small-scale dispersion, this equation is non-integrable and does not possess steady solitary wave solutions. If the amplitude of initial KdV soliton is sufficiently small, its evolution results in the emergence of envelope solitons which can be described by the nonlinear Schrodinger (NLS) equation. However, the earliear derived generalised NLS equation provided the results which were in contradiction with the numerical simulations. Here we revisit this problem and suggest a new approach to the derivation of the NLS equation and obtain solutions for the envelope solitons which agree with the numerical simulations.

15.7. Boundary consistency, open reductions, and intersection maps

Pieter Hubert van der Kamp (La Trobe University)

Wed 9 December 202013:50

Dr Pieter Hubert van der Kamp

I will discuss two recent preprints: [1] Integrable boundary conditions for quad equations, open boundary reductions and integrable mappings arXiv:2009.09854 [2] A new class of integrable maps of the plane: Manin transformations with involution curves, arXiv:2009.00412 In particular, I'll explain the idea of defining mappings using intersection of curves.

16. Number Theory and Algebraic Geometry

16.1. Approximated solution of a differential-difference equation arising in number theory and applications to the linear sieve

Matteo Bordignon (University of New South Wales Canberra)

Thu 10 December 202014:00

Mr Matteo Bordignon

I will provide elementary and accurate numerical solutions to the differential-difference equation, which improves an explicit version of the linear sieve given by Nathanson.

16.2. The generalised Hausdorff measure of sets of Dirichlet non-improvable numbers

Philip Bos (La Trobe University)

Wed 9 December 202014:50

P. Bos, M. Hussain, D. Simmons

Let $\psi : \mathbb{R}_+ \to \mathbb{R}_+$ be a non-increasing function. A real number x is said to be ψ-Dirichlet improvable if the system

$$|qx - p| < \psi(t) \quad \text{and} \quad |q| < t$$

has a non-trivial integer solution for all large enough t. Denote the collection of such points by $D(\psi)$. Hussain, Kleinbock, Wadleigh and Wang (2018) derived the Hausdorff measure of the set $D^c(\psi)$ (the set of ψ-Dirichlet non-improvable numbers), proving that it obeys a zero-infinity law for a large class of (essentially sub-linear) dimension functions (ESLDF). In this talk, we derive the generalised Hausdorff f-measure of the set $D^c(\psi)$ for non essentially sub-linear dimension functions (NESLDF). Hence, together with the Hussain, Kleinbock, Wadleigh and Wang (2018) result, we provide a complete characterisation of the generalised Hausdorff f-measure of the set $D^c(\psi)$.

The presentation style will be expository.

Reference

M. Hussain, D. Kleinbock, N. Wadleigh, and B.-W. Wang, Hausdorff measure of sets of Dirichlet non-improvable numbers, *Mathematika*, 64 (2018), pp. 502–518.

16.3. Estimation of sums over zeros of the Riemann zeta-function

Richard P Brent (Australian National University)

Thu 10 December 202016:00

Prof Richard P Brent

Consider sums of the form $\sum \phi(\gamma)$ where ϕ is a given function and γ ranges over the ordinates of nontrivial zeros of the Riemann zeta-function in a given interval. We show how the numerical estimation of such sums can be accelerated, improving in many cases on a well-known lemma of Lehman (1966), and give an example involving an analogue of the harmonic series. For a preprint, see arXiv:2009.13791. This is joint work with Dave Platt and Tim Trudgian.

16.4. Multiplicative orders of Gauss periods and real quadratic fields

Florian Breuer (The University of Newcastle)

Thu 10 December 202015:00
Prof Florian Breuer

Finite field elements of the form $x + x^{-1}$, where x has multiplicative order $p = 2n + 1$ and p is prime, are called Gauss periods of type $(n, 2)$. Such elements usually have high multiplicative order, and their special form makes them computationally useful. In this talk I will deduce some divisibility conditions on their multiplicative orders which arise from the arithmetic of the real quadratic field $\mathbb{Q}(\sqrt{p})$.

16.5. Updating the Bertrand-type estimate for primes in intervals

Michaela Cully-Hugill (University of New South Wales Canberra)

Thu 10 December 202013:30
Ms Michaela Cully-Hugill

Among the results for primes in intervals, we have the long interval estimate (x, Cx), for some $C > 1$ and sufficiently large x, which can be dated back to Bertrand's postulate (1845). This talk outlines recent work with Ethan Lee on updating this interval estimate. Kadiri and Lumley (2014) were the last to improve this type of estimate, and used analytic methods with a smoothing function argument from Ramaré and Saouter (2003). We build on Kadiri and Lumley's work by updating certain explicit estimates, and by parameterising Ramaré and Saouter's smoothing function.

16.6. Smoothed Pólya–Vinogradov Inequalities

Forrest James Francis (Australian Defence Force Academy)

Wed 9 December 202013:50
Mr Forrest Francis

Given a Dirichlet character modulo q, the Pólya–Vinogradov inequality tells us that the size of the associated character sum is no larger than $q^{\frac{1}{2}} log(q)$. By introducing a smoothing factor to the character sum, Levin, Pomerance, and Soundararajan showed that one can obtain an estimate that is instead in the order of $q^{\frac{1}{2}}$. In this talk, we will discuss a generalisation of their "smoothed" Pólya–Vinogradov which allows for a wider variety of weights.

16.7. On sparse geometry of numbers

Lenny Fukshansky (Claremont McKenna College)

Wed 9 December 202012:50
Lenny Fukshansky

Let L be a lattice of full rank in n-dimensional real space. A vector in L is called i-sparse if it has no more than i nonzero coordinates. We define the i-th successive sparsity level of L, $s_i(L)$, to be the minimal s so that L has s linearly independent i-sparse vectors, then $s_i(L) \leq n$ for each $1 \leq i \leq n$. We investigate sufficient conditions for $s_i(L)$ to be smaller than n and obtain explicit bounds on the sup-norms of the corresponding linearly independent sparse vectors in L. This result can be viewed as a partial sparse analogue of Minkowski's successive minima theorem. We then use this result to study virtually rectangular lattices, establishing conditions for the lattice to be virtually rectangular and determining the index of a rectangular sublattice. We further investigate the 2-dimensional situation, showing that virtually rectangular lattices in the plane correspond to elliptic curves isogenous to those with real j-invariant. We also identify planar virtually rectangular lattices in terms of a natural rationality condition of the geodesics on the modular curve carrying the corresponding points. This is joint work with Pavel Guerzhoy and Stefan Kuehnlein.

16.8. The fourth moment of quadratic Hecke L-functions in $Q(i)$

Peng Gao (Beihang University)

Tue 8 December 202014:50
Prof Peng Gao

In this talk, we study the fourth moment of central values of quadratic Hecke L-functions in the Gaussian field. We show an asymptotic formula valid under the generalized Riemann hypothesis (GRH). We also present precise lower bounds unconditionally and upper bounds under GRH for higher moments of the same family.

16.9. Solutions of generalizations of Markoff equation from linear recurrences

Hayder Hashim (Institute of Mathematics, University of Debrecen)

Wed 9 December 202017:20

Mr Hayder Hashim

The Diophantine equation

$$X^2 + Y^2 + Z^2 = 3XYZ \tag{1}$$

in positive integers $X \leq Y \leq Z$ is called the Markoff equation, which was deeply studied by Markoff [**2**] demonstrating a relationship between its integer solutions (so-called Markoff triples) and Diophantine approximation. He obtained many interesting results related to the Markoff triples. He showed that there are infinitely many Markoff triples, which can be generated from the fundamental solution $(1, 1, 1)$ and the branching operation

$$\begin{array}{ccc} & (X, Y, Z) & \\ \swarrow & & \searrow \\ (X, Z, 3XZ - Y). & & (Y, Z, 3YZ - X). \end{array}$$

This equation has been generalized by several authors. For instance, Rosenberger [**3**], studied the integral solutions of the equation

$$AX^2 + BY^2 + BZ^2 = DXYZ. \tag{2}$$

Rosenberger proved that if $A, B, C, D \in \mathbb{N}$ are integers such that $\gcd(A, B) = \gcd(A, C) = \gcd(B, C) = 1$ and $A, B, C|D$, then non-trivial solutions exist only if

$$(A, B, C, D) \in \{(1, 1, 1, 1), (1, 1, 1, 3), (1, 1, 2, 2), (1, 1, 2, 4), (1, 1, 5, 5), (1, 2, 3, 6)\}.$$

This equation is often called the Markoff-Rosenberger equation. The Markoff-Rosenberger equation was generalized by Jin and Schmidt [**1**] in which they determined the solutions $(X, Y, Z) \in \mathbb{N}^3$ of the equation

$$AX^2 + BY^2 + CZ^2 = DXYZ + 1. \tag{3}$$

Jin and Schmidt showed that equation (3) has a fundamental solution if and only if

$$\begin{aligned} (A, B, C, D) \in \{&(2, 2, 3, 6), (2, 1, 2, 2), (7, 2, 14, 14), (3, 1, 6, 6), (6, 10, 15, 30) \\ &(5, 1, 5, 5), (1, b, b, 2b)\}, \text{with } b \in \mathbb{N}. \end{aligned}$$

In this talk we first focus on investigating the solutions of the Jin-Schmidt equation (3) for which $(X, Y, Z) = (F_I, F_J, F_K)$, where F_n denotes the n-th Fibonacci number for any integer $n > 1$. Then, we give a general result for studying the solutions $(X, Y, Z) = (U_i, U_j, U_k)$, where U_i denotes the i-th generalized Lucas number of first/second kind, of the Markoff-Rosenberger equation (2), and we apply the result to completely resolve concrete equations, e.g. we determine solutions containing only balancing numbers and Jacobsthal numbers, respectively.

This is a joint work with my supervisor (Szabolcs Tengely from University of Debrecen/ Hungary) and (László Szalay from University of Sopron/ Hungary).

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16.10. Sums of arithmetic functions involving the gcd and lcm

Randell Heyman (University of New South Wales)

Thu 10 December 202015:30
Mr Randell Heyman

In 1985 Chidambaraswamy and Sitaramachandrarao gave an asymptotic formula for $\sum_{1\leq m,n\leq x} \gcd(m,n)$. In the last 20 years results for many generalisations have been published. I will outline some recent results summing $f(\gcd(m,n)$ for f in various classes of arithmetic functions. These include $f = \tau, \log, \omega and \Omega$. Some results involving the lowest common multiple will also be explored. Many of the results are joint work with László Tóth.

16.11. Rational Preperiodic Points for Endomorphisms of Projective Space with Automorphisms

Benjamin Hutz (Saint Louis University)

Thu 10 December 202013:00
Prof Benjamin Hutz

Let f be an endomorphism of the projective line. There is a natural conjugation action on the space of such morphisms by elements of the projective linear group. The group of automorphisms, or stabilizer group, of a given f for this action is known to be a finite group. Having recently determined explicit families that parameterize all endomorphisms defined over $\bar{\mathbb{Q}}$ of degree 3 and degree 4 that have a nontrivial automorphism, we now study the possible structures of $\mathbb{Q}$-rational preperiodic points which occur under specialization. The Morton-Silverman Uniform Boundedness conjecture predicts an upper bound on the number of possible structures. We give an explicit classification of possible structures for these families utilizing techniques for rational points on curves and under mild assumptions on the number of rational periodic points.

16.12. Comparing Results to study the Distribution of Prime Ideals in a Number Field

Ethan Simpson Lee (UNSW Canberra)

Wed 9 December 202015:20
Mr Ethan Simpson Lee

Since the conjectures of Gauss and Legendre, mathematicians sought to prove the prime number theorem. Twenty-two years before this proof was possible, Mertens' proved a set of weaker, but useful, theorems known as Mertens' theorems. Today, the prime number theorem is indisputably the most important result for the distribution of prime numbers. Both Mertens' theorems and the prime number theorem have been generalised to a number field setting, in Mertens' theorems for number fields and the prime ideal theorem respectively. Playing the same game of analogies, is the prime ideal theorem more useful than Mertens' theorems for studying the distribution of prime ideals in a number field? If not, then why not? This is the topic of discussion in my talk.

16.13. The Solomon zeta function

Sean Lynch (UNSW Sydney)

Wed 9 December 202015:50
Mr Sean Lynch

For a nonnegative integer n, let $R(n)$ be the polynomial ring with integer coefficients and n indeterminants. Now, for a positive integer m and a nonnegative integer n, let $\Lambda(m,n)$ be the ring of m by m matrices with entries in $R(n)$. We want to study how left ideals of $\Lambda(m,n)$ are distributed by index. Thus, we work with an associated Dirichlet series, the Solomon zeta function of $\Lambda(m,n)$. Indeed, $\Lambda(1,0)$ is the ring of integers and its (Solomon) zeta function is the Riemann zeta function $\zeta(s)$. Hey (1927) showed that, for all m, the zeta function of $\Lambda(m,0)$ can be expressed as the product $\zeta(ms)\zeta(ms-1)\cdots\zeta(ms-m+1)$; in fact, Hermite (1851) and Eisenstein (1852) essentially knew this. Furthermore, Segal (1997) showed that the zeta function of $\Lambda(1,1)$ can be expressed as the infinite product $\zeta(s-1)\zeta(2s-2)\cdots$; Lustig (1955) essentially knew this and Fukshanky et al. (2017) independently rediscovered the formula. It turns out that the zeta function of $\Lambda(1,n)$ diverges at every complex number if $n>1$, as Witt (1969) showed. It then follows from Morita equivalence that, for all m and for all $n>1$, the zeta function of $\Lambda(m,n)$ diverges at every complex number. This leaves us with the case when $m>1$ and $n=1$. Having developed a noncommtuative version of the Lustig-Segal method, we obtain a formula for the zeta function of $\Lambda(m,n)$ in this case.

16.14. Correlation between Salié sums and second moments of some half integral weight L-series

Igor Shparlinski (UNSW Sydney)

Tue 8 December 202016:20

Ilya Shkredov, Igor Shparlinski and Alexandru Zaharescu

In 2019, A. Dunn and A. Zaharescu obtained an asymptotic formula for moments of with a power saving in the error term for second moments of L-functions modulo a prime q associated with some eigenforms of half integral weight. Among other tool this result is based on a nontrivial bound on correlations between Salié sums.

In this talk we discuss recent improvements of this bound due to A. Dunn, B. Kerr, I. E. Shparlinski and A. Zaharescu (2020) for all q and to I. Shkredov, I. E. Shparlinski and A. Zaharescu (2020) for almost all q. As an application, we show that for almost all primes q the error term in the asymptotic formuls for the moments is of order at most $q^{-1/52}$, while for all q the result of A. Dunn and A. Zaharescu (2019) gives $q^{-1/600}$.

16.15. Computing the fourth term of of Nathanson's lambda $\lambda_{2,3}(h)$ sequence and limit points of $\lambda_{2,n}(h)$ sequences.

Satyanand Singh (NYCCT of CUNY)

Wed 9 December 202013:20

Dr Satyanand Singh

We consider the set

$$A_n = \cup_{j=0}^{\infty}\{\varepsilon_j(n)\cdot n^j : \varepsilon_j(n) \in \{0,\pm1,\pm2,...,\pm\lfloor n/2\rfloor\}\}.$$

Let $\mathcal{S}_{\{2,3\}} = A_2 \cup A_3$. We denote $\lambda_{2,3}(h)$ to be the smallest positive integer that can be represented as a sum of h, and no less than h elements in $\mathcal{S}_{\{2,3\}}$. Nathanson studied the properties of the $\lambda_{2,3}$ sequence and posed the problem of finding the values of $\lambda_{2,3}(h)$, for $h \geq 4$, which are very important in geometric group theory and additive number theory. In this presentation, we will illustrate how to generate $\lambda_{2,3}(4)$. Our technique involve establishing the insolubility of certain exponential diophantine equations. We will also show how to compute the associated limit points for $\lambda_{2,n}(h)$, when $n>1$ is odd and $h \in \{1,2,3\}$.

16.16. To the median of the even leg of a pPT and to the prime numbers of the form $p \equiv 1(\mod 12)$.

Ralf Steiner (NWF (LI))

Wed 9 December 202016:50

Dr Ralf Steiner

For a primitive Pythagorean triangle pPT(x,y,z) with $x^2+y^2=z^2$ let x be the odd and y the even leg. Then $\frac{y}{2}$ is always integer. The y-side median s_y thus satisfies the Pythagorean equation: $x^2+(\frac{y}{2})^2=s_y^2$. It can be shown that for primitive Pythagorean triangles pPT(x,y,z), y even for the y-side median s_y yields:

(1) s_y is an irrational square root;
(2) s_y^2 consists only of (multiple) prime factors p_i with $p_i \equiv 1(\mod 12)$;
(3) $s_y^2 \equiv 1(\mod 12)$.

16.17. Sign changes in the prime number theorem: past and present!

Timothy Trudgian (UNSW Canberra)

Thu 10 December 202016:30

Assoc Prof Timothy Trudgian

Past Tim has recorded some slides on estimating the number of sign changes in the prime number theorem. Present Tim will give live action commentary over the top of these slides. Nothing could possibly go wrong!

This is joint with with Thomas Morrill and Dave Platt.

17. Optimisation

17.1. Displacement mappings and fixed point sets of compositions of projections

Heinz Bauschke (University of British Columbia, Okanagan)

Fri 11 December 202014:00

Prof Heinz Bauschke

Projection operators and associated projection algorithms are fundamental building blocks in fixed point theory and optimization.

In this talk, I will survey recent results on the displacement mapping of the right-shift operator and sketch a new application deepening our understanding of the geometry of the fixed point set of the composition of projection operators in Hilbert space.

Based on joint work with Salha Alwadani, Julian Revalski, and Shawn Wang.

17.2. Necessary Conditions for Non-Intersection of Collections of Sets

Thi Hoa Bui (Curtin University)

Tue 8 December 202015:50

Dr Thi Hoa Bui

We study elementary nonintersection properties of collections of sets, making the core of the conventional definitions of extremality and stationarity. In the setting of general Banach/Asplund spaces, we establish new primal (slope) and dual (generalized separation) necessary conditions for these nonintersection properties. The results are applied to convergence analysis of alternating projections.

17.3. Generalized Bregman envelopes and proximity operators

Regina S. Burachik (University of South Australia)

Tue 8 December 202014:50

Regina S. Burachik, Minh N. Dao, and Scott B. Lindstrom

Every maximally monotone operator can be associated with a family of convex functions, called the Fitzpatrick family or family of representative functions. Surprisingly, in 2017, Burachik and Martínez-Legaz showed that the well-known Bregman distance is a particular case of a general family of distances, each one induced by a specific maximally monotone operator and a specific choice of one of its representative functions. For the family of generalized Bregman distances, sufficient conditions for convexity, coercivity, and supercoercivity have recently been furnished. Motivated by these advances, we introduce the generalized left and right envelopes and proximity operators, and we provide asymptotic results for parameters. Certain results extend readily from the more specific Bregman context, while others only extend for certain generalized cases. To illustrate, we construct examples from the Bregman generalizing case, together with the natural "extreme" cases that highlight the importance of which generalized Bregman distance is chosen.

17.4. Multivariate Extensions of a Generalized Newton Method

Bethany Caldwell (University of South Australia)

Thu 10 December 202014:00

Miss Bethany Caldwell

It is well known that Newton's method may not converge when the initial guess does not belong to a specific quadratic convergence region. We propose a family of new variants of the Newton method with the potential advantage of having a larger convergence region. In this talk we will present results regarding the quadratic convergence of the new family, and provide specific bounds for the asymptotic error constant. We illustrate the advantages of the new method by means of test problems comparing the new method to Newton's method. We will also show the merits of this method visually over a complex region for univariate examples.

17.5. Weak convergence of the adaptive Douglas–Rachford algorithm

Ruben Campoy (Universitat de Valencia)

Fri 11 December 202010:30

Dr Ruben Campoy

The adaptive Douglas–Rachford algorithm permits to find zeros of the sum of a maximally strongly monotone operator and a maximally weakly monotone one. As it happens with its classical counterpart, the sequence of interest is not the one generated by the algorithm but the one of its shadows (its evaluation through one of the resolvents). The weak convergence of the shadow sequence cannot be directly derived since, in general, resolvent are not weakly continuous. Nonetheless, a multioperator demiclosedness principle for firmly nonexpansive mappings is useful in obtaining simple and transparent arguments for the weak convergence of the shadow sequence generated by the classical Douglas–Rachford algorithm. In this talk, we provide extensions of this principle, which are compatible with the framework of more general families of mappings such as cocoercive and conically averaged mappings. As an application, we derive the weak convergence of the shadow sequence generated by the adaptive Douglas–Rachford algorithm. (Joint work with Sedi Bartz and Hung Phan)

17.6. LP Based Bounds for Cesaro and Abel Limits of the Optimal Values in Non-ergodic Stochastic Systems

Lucas Gamertsfelder (Macquarie University)

Wed 9 December 202014:20

Lucas Gamertsfelder, Konstantin Avrachenkov, Vladimir Gaitsgory

We will discuss asymptotic properties of control problems of stochastic discrete time systems with time averaging and time discounting optimality criteria, and we will establish that the Cesaro and Abel limits of the optimal values in such problems can be estimated with the help of a certain infinite-dimensional (ID) linear programming (LP) problem and its dual.

This talk is based on results obtained in:

K. Avrachenkov, V. Gaitsgory and L. Gamertsfelder, "LP Based Upper and Lower Bounds for Cesaro and Abel Limits of the Optimal Values in Problems of Control of Stochastic Discrete Time Systems", Archived, https://arxiv.org/abs/2010.15375v2.

17.7. Logic-Based Benders Decompostion for Resource Allocation Problems

Mitchell Harris (The University of Queensland)

Wed 9 December 202013:50

Mr Mitchell Harris

Logic-based Benders decomposition (LBBD) is an ambitious generalization of J. F. Benders' classical decomposition strategy for mixed-integer optimization problems. We apply LBBD to a class of resource allocation problems which are characterized by monotonically non-decreasing performance measures. In this talk we will focus on the following special case. We are given a set of jobs and a set of time periods. We want to allocate staff to the time periods in order to minimize the total delay of all jobs, where each job needs to be processed by an available staff member, and are scheduled on a first-come-first-serve basis. Conventional mixed-integer optimization methods are inadequate for these problems, because formulating them would require a large number of new variables and constraints. With logic-based Benders decomposition on the other hand, we are able to solve hard instances to optimality in a reasonable time-frame. It time allows, we will discuss how this approach can be applied in much greater generality.

17.8. Distributionally Robust Chance-Constrained Programs under Wasserstein Ambiguity

Nam Ho-Nguyen (The University of Sydney)

Fri 11 December 202011:30

Dr Nam Ho-Nguyen

We consider exact deterministic mixed-integer programming (MIP) reformulations of distributionally robust chance-constrained programs (DR-CCP) over Wasserstein ambiguity sets. The existing MIP formulations are known to have weak continuous relaxation bounds, and, consequently, for hard instances with small radius, or with large problem sizes, the branch-and-bound based solution processes suffer from large optimality gaps even after hours of computation time. This significantly hinders the practical application of the DR-CCP paradigm. Motivated by these challenges, we conduct a polyhedral study to strengthen these formulations. We reveal several hidden connections between DR-CCP and its nominal counterpart (the sample average approximation), mixing sets, and robust 0-1 programming. By exploiting these connections in combination, we provide an improved formulation and two classes of valid inequalities for DR-CCP. We test the impact of our results on a stochastic transportation problem numerically. Our experiments demonstrate the effectiveness of our approach; in particular our improved formulation and proposed valid inequalities reduce the overall solution times remarkably. Moreover, this allows us to significantly scale up the problem sizes that can be handled in such DR-CCP formulations by reducing the solution times from hours to seconds.

17.9. Some Applications of Multiobjective Optimal Control

Yalcin Kaya (University of South Australia)

Fri 11 December 202012:00

Dr Yalcin Kaya

Pareto minimization of multiple objective functionals/costs in optimal control is the process of finding a compromise solution, referred to as a Pareto minimum, where any of the costs cannot be improved (i.e., reduced) further, without making the values of some of the other costs worse (i.e., higher). The set of all such compromise solutions form the Pareto set, or the Pareto front. In this talk, methods will be described to obtain the Pareto fronts of optimal control problems. Optimization over the Pareto front will also be considered. The latter is especially useful in the instances when construction of the Pareto front is costly or the viewing of the Pareto front is not easy, if not impossible. We will discuss examples, including tumour anti-angiogenesis, problems involving minimization of the total control variation, and trajectory planning for search-and-rescue operations. This talk contains joint work with Henri Bonnel, Regina Burachik and Helmut Maurer.

17.10. Mission Path Planning for Optimal ISAR Vessel Classification

David Kirszenblat (Defence Science and Technology Group)

Thu 10 December 202013:00

Dr David Kirszenblat

In this talk, we present initial work on the problem of path planning in maritime surveillance where there is a priority to optimise inverse synthetic aperture radar (ISAR) imaging. What makes this problem unique is the combination of kinematic constraints on the surveillance platform and the constraints involved in ISAR imaging, per se. We formulate the problem as a curvature constrained traveling salesman problem, where the path visits a set of lines or sectors in the plane as opposed to a set of nodes. Our approach to solving the problem splits into two phases. First, a promising seed solution is obtained via a nearest neighbour algorithm, a genetic algorithm or linear programming. Second, the seed solution is refined via a gradient descent method, which is inspired by a mechanical model. We compare the outputs of the various approaches in terms of the path length, computation time and path complexity. In future work, we will extend the algorithm to dynamic conditions, where the path is updated upon detection of new vessels.

17.11. A Chasing Douglas–Rachford Splittng Method for Feasibility Problem

Jingwei Liang (Queen Mary University of London)

Fri 11 December 202011:00

Dr Jingwei Liang; Dr Clarice Poon

Projection based algorithms, including (relaxed) Alternating Projection and Douglas–Rachford splitting methods, are popular approaches to solve feasibility problems. Depending on the geometry of the underlying sets, significant difference in performance can be observed for these methods. In this talk, I will present a novel development of Douglas–Rachford splitting method for solving feasibility problem. The proposed method combines the advantages of both Alternating Projection and Douglas–Rachford splitting. Numerical result will be presented to verify the improvements of the new method.

17.12. Computable centering methods for spiraling algorithms and their duals, with motivations from the theory of Lyapunov functions

Scott Boivin Lindstrom (Hong Kong Polytechnic University)

Fri 11 December 202016:00

Dr Scott Boivin Lindstrom

Circumcentering reflection methods (CRMs) have been shown to obviate spiraling for Douglas–Rachford Method (DR) for certain feasibility problems. I will show how CRMs, subgradient projections, and Newton–Raphson are all describable as gradient-based methods for minimizing Lyapunov functions constructed for DR operators, with the former returning the minimizers of quadratic surrogates for the Lyapunov function. I will then introduce a new centering method that shares these properties with the added advantages that it: 1) does not rely on subproblems (e.g. reflections) and so may be applied for any operator whose iterates spiral; 2) provably has the aforementioned Lyapunov properties with few structural assumptions and so is generically suitable for primal/dual implementation; and 3) maps spaces of reduced dimension into themselves whenever the original operator does. This makes possible the first primal/dual implementation of a centering method for accelerating Alternating Direction Method of Multipliers. I'll show how it works.

Reference: Scott B. Lindstrom, "Computable centering methods for spiraling algorithms and their duals, with motivations from the theory of Lyapunov functions," arXiv preprint arXiv:2001.10784, (2020)

17.13. A Primal-Dual Method with Applications to Optimal Control

Xuemei Liu (University of South Australia)

Wed 9 December 202016:20

Miss Xuemei Liu

We propose a duality scheme for solving constrained non-smooth and non-convex optimization problems in a reflexive Banach space. We solve the dual problem (in a Hilbert space) using a deflected subgradient method via a general augmented Lagrangian. We provide two choices of step-size for the method. For both choices, we prove that every weak accumulation point of the primal sequence is a primal solution. We implement our method numerically on optimal control problems.

17.14. Random Function Iterations for Stochastic Fixed Point Problems

Russell Luke (University of Goettingen)

Wed 9 December 202017:20

Prof Russell Luke

We study the convergence of random function iterations for finding an invariant measure of the corresponding Markov operator. We call the problem of finding such an invariant measure the *stochastic fixed point problem*. This generalizes earlier work studying the *stochastic feasibility problem*, namely, to find points that are, with probability 1, fixed points of the random functions [HermerLukeSturm, 2019]. When no such points exist, the stochastic feasibility problem is called *inconsistent*, but still under certain assumptions, the more general stochastic fixed point problem has a solution and the random function iterations converge to an invariant measure for the corresponding Markov operator. There are two major types of convergence: almost sure convergence of the iterates to a fixed point in the case of stochastic feasibility, and convergence in distribution more generally. We show how common structures in deterministic fixed point theory can be exploited to establish existence of invariant measures and convergence of the Markov chain. We show that weaker assumptions than are usually encountered in the analysis of Markov chains guarantee linear/geometric convergence. This framework specializes to many applications of current interest including, for instance, stochastic algorithms for large-scale distributed computation, and deterministic iterative procedures with computational error. The theory developed in this study provides a solid basis for describing the convergence of simple computational methods without the assumption of infinite precision arithmetic or vanishing computational errors.

17.15. The extension of linear inequality method for generalised rational Chebyshev approximation.

Vinesha Peiris (Swinburne University of Technology)

Thu 10 December 202013:30

Miss Vinesha Peiris

In this talk we will demonstrate the correspondence between the linear inequality method developed for rational Chebyshev approximation and the bisection method used in quasiconvex optimisation. It naturally connects rational and generalised rational Chebyshev approximation problems with modern developments in the area of quasiconvex functions. Moreover, the linear inequality method can be extended to a broader class of Chebyshev approximation problems, where the corresponding objective functions remain quasiconvex.

17.16. New Gradient and Hessian Approximation Methods for Derivative-free Optimisation

Chayne Planiden (University of Wollongong)

Wed 9 December 202015:20

Dr Chayne Planiden

In general, derivative-free optimisation (DFO) uses approximations of first- and second-order information in minimisation algorithms. DFO is found in direct-search, model-based, trust-region and other mainstream optimisation techniques and is gaining popularity in recent years. This work discusses previous results on some particular uses of DFO: the proximal bundle method and the VU-algorithm, and then presents improvements made this year on the gradient and Hessian approximation techniques. These improvements can be inserted into any routine that requires such estimations.

17.17. Convergence rate analysis of a sequential convex programming method with line search for a class of constrained difference-of-convex optimization problems

Ting Kei Pong (Hong Kong Polytechnic University)

Wed 9 December 202012:50

Dr Ting Kei Pong

In this talk, we discuss the sequential convex programming (SCP) method with line search for a class of difference-of-convex (DC) optimization problems with multiple smooth inequality constraints. We analyze the convergence rate of the sequence generated in both nonconvex and convex settings by imposing suitable Kurdyka-Lojasiewicz (KL) assumptions. We also discuss when the KL exponent of the extended objective function (i.e., sum of the objective and the indicator function of the constraint set) can be deduced from its Lagrangian in the convex settings. Based on this, we show under mild assumptions that the extended objectives of some constrained optimization models such as minimizing l1 norm subject to logistic/Poisson loss are KL functions with exponent 1/2. Finally, we apply our results to some compressed sensing models with residual errors measured by the l2 norm or the Lorentzian norm.

This is joint work with Zhaosong Lu and Peiran Yu.

17.18. Make Alternating Projections great again

Björn Rüffer (The University of Newcastle)

Fri 11 December 202015:00

Dr Björn Rüffer

The Method of Alternating Projections (MAP), also known as Projections onto Convex Sets (POCS) is a staple of solving feasibility problems that dates back to the days of John von Neumann, who considered intersections of affine spaces, which was subsequently expanded to closed, convex sets in Hilbert space. While nowadays convergence is well understood, it can be rather slow. We will consider improvements to speed up convergence.

17.19. A learning-enhanced projection method for solving convex feasibility problems

Janosch Rieger (Monash University)

Fri 11 December 202015:30

Dr Janosch Rieger

The topic of this talk is a generalization of the method of cyclic projections, which uses the lengths of projection steps carried out in the past to learn about the geometry of the problem and decides on

this basis which projections to carry out in the future. We prove the convergence of this algorithm and illustrate its behavior in a
first numerical study.

17.20. Block Methods for Scalable Derivative-Free Optimisation

Lindon Roberts (Australian National University)

Wed 9 December 202013:20
Dr Lindon Roberts

Derivative-free optimisation (DFO) methods are an important class of optimisation routines with applications in areas such as in image analysis and data science. However, in model-based DFO methods, the computational cost of constructing local models can be high. As a result, these algorithms are not as suitable for large-scale problems as derivative-based methods. In this talk, I will introduce a derivative-free method based on exploration of random subspaces, suitable for nonlinear least-squares problems. This method has a substantially reduced computational cost (in terms of linear algebra), while still making progress using few objective evaluations.

17.21. Amenable, nice and projectively exposed cones: new relations and open problems

Vera Roshchina (UNSW Sydney)

Wed 9 December 202015:50
Dr Vera Roshchina

Amenable cones were introduced recently by Bruno Lourenço in the context of error bounds. It is known that many closed convex cones commonly used in convex optimisation are amenable, but the relations between amenability and other properties such as niceness and projective exposure are not fully understood.

It is known that nice and projectively exposed cones are amenable, however the converse have been open questions. I will show that it is possible to construct an example of a four-dimensional cone that is amenable but not nice and that amenable cones are projectively exposed in dimensions up to and including four. I will also mention more nuanced statements related to geometry of convex cones and introduce open problems that my coauthors and I weren't able to fully resolve.

The talk is based on joint work with Bruno Lourenço and James Saunderson.

17.22. Faster Lagrangian-Based Methods in Convex Optimization

Shoham Sabach (Technion, Israel Institute of Technology)

Tue 8 December 202016:20
Prof Shoham Sabach

We aim at unifying, simplifying, and improving the convergence rate analysis of Lagrangian-based methods for convex optimization problems. We first introduce the notion of nice primal algorithmic map, which plays a central role in the unification and in the simplification of the analysis of all Lagrangian-based methods. Equipped with a nice primal algorithmic map, we then introduce a versatile generic scheme, which allows for the design and analysis of Faster LAGrangian (FLAG) methods with a new provably sublinear rate of convergence expressed in terms of functions values and feasibility violation of the original (non-ergodic) generated sequence. To demonstrate the power and versatility of our approach and results, we show that all well-known iconic Lagrangian-based schemes admit a nice primal algorithmic map, and hence share the new faster rate of convergence results within their corresponding FLAG.

17.23. Regularization Parameter Tracking in Machine Learning

Christopher Schneider (University of Applied Sciences Jena)

Fri 11 December 202010:00
Prof Christopher Schneider

Regularized loss minimization, where a statistical model is obtained from minimizing the sum of a loss function ℓ and weighted regularization terms r_i, is still in widespread use in machine learning:

$$(\mathrm{P}_\alpha) \qquad \min_{x\in\mathcal{F}} \ \ell(x) + \sum_{i=1}^{q} \alpha_i r_i(x)\,.$$

The statistical performance of the resulting models depends on the choice of weights α_i (regularization parameters) that are typically tuned by cross-validation. For finding the best regularization parameters, the regularized minimization problem (P_α) needs to be solved for the whole parameter domain. A practically more feasible approach is covering the parameter domain with approximate solutions of the loss minimization problem for some prescribed approximation accuracy. The problem of computing such a covering is known as the *approximate solution gamut problem*.

Existing algorithms for the solution gamut problem suffer from several problems. For instance, they require a grid on the parameter domain whose spacing is difficult to determine in practice, and they are not generic in the sense that they rely on problem specific plug-in functions. Here, we show that a well-known algorithm from vector optimization, namely *Benson's algorithm*, can be used directly for computing approximate solution gamuts while avoiding the problems of existing algorithms.

Experiments on real world data sets demonstrate the effectiveness of Benson's algorithm for regularization parameter tracking.

17.24. Projected Subgradient Methods in Infinite Dimensional Spaces

Hong-Kun Xu (Hangzhou Dianzi University)

Wed 9 December 202016:50

Prof Hong-Kun Xu

Subgradient methods, introduced by Shor and developed by Albert, Iusem, Nesterov, Polyak, Soloov, and many others, are used to solve nondifferentiable optimization problems. The major differences from the gradient descent methods (or projection-gradient methods) for differentiable optimization problems lie in the selection manners of the step-sizes. For instance, constant step-sizes for differentiable objective functions no longer work for nondifferentiable objective functions; for the latter case, diminishing step-sizes must however be adopted.

In this talk, we will first review some existing projected subgradient methods and the main purpose is to discuss weak and strong convergence of projected subgradient methods in an infinite-dimensional Hilbert space. Some regularization technique for strong convergence of projected subgradient methods will particularly be presented. Extension to the proximal-subgradient method for minimizing the sum of two nondifferentiable convex functions will also be discussed.

17.25. An ADMM-Newton-CNN Numerical Approach to a TV Model for Identifying Discontinuous Diffusion Coefficients in Elliptic Equations: Convex Case with Gradient Observations

Xiaoming Yuan (The University of Hong Kong)

Thu 10 December 202014:30

Prof Xiaoming Yuan

Identifying the discontinuous diffusion coefficient in an elliptic equation with observation data of the gradient of the solution is an important nonlinear and ill-posed inverse problem. Models with total variational (TV) regularization have been widely studied for this problem, while the theoretically required nonsmoothness property of the TV regularization and the hidden convexity of the models are usually sacrificed when numerical schemes are considered in the literature. In this paper, we show that the favorable nonsmoothness and convexity properties can be entirely kept if the well-known alternating direction method of multipliers (ADMM) is applied to the TV-regularized models, hence it is meaningful to consider designing numerical schemes based on the ADMM. Moreover, we show that one of the ADMM subproblems can be well solved by the active-set Newton method along with the Schur complement reduction method, and the other one can be efficiently solved by the deep convolutional neural network (CNN). The resulting ADMM-Newton-CNN approach is demonstrated to be easily implementable and very efficient even for higher-dimensional spaces with fine mesh discretization.

18. Partial Differential Equations

18.1. Reaction-diffusion model with nonlocal diffusion and free boundaries

Ting-Ying Chang (University of New England)

Wed 9 December 202016:20

Dr Ting-Ying Chang

In this talk, we consider a reaction-diffusion epidemic model with nonlocal diffusion and free boundaries. This free-boundary epidemic model includes the diffusion of the infective host population, as well as generalises nonlocal diffusions for both populations. We introduce the reproduction number R_0, and establish its relationship to the spreading-vanishing dichotomy via the corresponding eigenvalue problem. If $R_0 \leqslant 1$, we prove that the epidemic tends to vanish. On the other hand, if $R_0 > 1$, we show that spreading and vanishing may still occur depending on its initial size. In the case of spreading, we also append results on the spreading speed for completeness.

18.2. Anisotropic elliptic equations with gradient-dependent lower order terms and L^1 data

Florica Corina Cirstea (The University of Sydney)

Thu 10 December 202015:30

Assoc Prof Florica Corina Cirstea

We prove the existence of a weak solution to the Dirichlet problem

$$\begin{cases} \mathcal{A}u - \mathfrak{B}u + \Phi(x, u, \nabla u) = f & \text{in } \Omega, \\ u \in W_0^{1,\overrightarrow{p}}(\Omega), \quad \Phi(x, u, \nabla u) \in L^1(\Omega), \end{cases}$$

where Ω is a bounded open subset of $\mathbb{R}^N$ with $N \geq 2$. Here $\mathcal{A}$ is a divergence-form nonlinear anisotropic operator, the prototype of which is $-\Delta_{\overrightarrow{p}} u = -\sum_{j=1}^N \partial_j(|\partial_j u|^{p_j-2}\partial_j u)$ with $p_j > 1$ for all $1 \leq j \leq N$ and $\sum_{j=1}^N (1/p_j) > 1$. We make suitable assumptions on the operator $\mathfrak{B}$ so that $\mathcal{A} - \mathfrak{B}$ is coercive from $W_0^{1,\overrightarrow{p}}(\Omega)$ into $W^{-1,\overrightarrow{p}'}(\Omega)$ and it maps bounded sets into bounded sets. We allow the presence of a gradient-dependent lower order term Φ, that grows like $\sum_{j=1}^N |\partial_j u|^{p_j}$, and any function $f \in L^1(\Omega)$. This is joint work with Barbara Brandolini (University of Naples).

18.3. Nonlocal logistic equations with Neumann conditions

Serena Dipierro (The University of Western Australia)

Wed 9 December 202012:50

Prof Serena Dipierro

We consider a problem of population dynamics modeled on a logistic equation with both classical and nonlocal diffusion, possibly in combination with a pollination term. The environment considered is a niche with zero-flux, according to a new type of Neumann condition. We discuss the situations that are more favorable for the survival of the species, in terms of the first positive eigenvalue. The eigenvalue analysis for the one dimensional case is structurally different than the higher dimensional setting, and it sensibly depends on the nonlocal character of the dispersal. We also analyse the role played by the optimization strategy in the distribution of the resources, also showing concrete examples that are unfavorable for survival, in spite of the large resources that are available in the environment.

18.4. Sharp existence and classification results for nonlinear elliptic equations in $\mathbb{R}^N \setminus \{0\}$ with Hardy potential

Maria Farcaseanu (The University of Sydney)

Thu 10 December 202014:30

Dr Maria Farcaseanu

We reveal the structure and asymptotic behaviour near zero and infinity of all positive solutions for the nonlinear elliptic equation with Hardy potential $(\star)$ $-\Delta u - \frac{\lambda}{|x|^2} u + |x|^\theta u^q = 0$ in $\mathbb{R}^N \setminus \{0\}$ $(N \geq 3)$, where $q > 1$, $\theta \in \mathbb{R}$ and $\lambda \in \mathbb{R}$ are arbitrary. We provide the sharp range of the parameters such that there exist positive solutions of $(\star)$ in $\mathbb{R}^N \setminus \{0\}$. We show that equation $(\star)$ has either a unique solution or infinitely many solutions or no positive solutions. This is joint work with Florica Cîrstea.

18.5. A new representation for the Landau-de Gennes energy of nematic liquid crystals

Zhewen Feng (The University of Queensland)

Wed 9 December 202014:20

Mr Zhewen Feng

In the Landau-de Gennes theory on nematic liquid crystals, the well-known Landau-de Gennes energy depends on four elastic constants; L_1, L_2, L_3, L_4. For the general case of $L_4 \neq 0$, Ball-Majumdar found an example in 2010 that the Landau-de Gennes energy functional from physics literature does not satisfy a coercivity condition, which causes a problem in mathematics to establish the existence of energy minimizers. In order to solve this problem, we observe that the original third order term on L_4, proposed by Schiele and Trimper in 1983, is a linear combination of a fourth-order term and a second-order term. Therefore, we can propose a new Landau-de Gennes energy, which is equal to the original for uniaxial nematic Q-tensors. The new Landau-de Gennes energy with general elastic constants satisfies the coercivity condition for all Q-tensors, which establishes a new link between mathematical and physical theory. Similarly to the work of Majumdar-Zarnescu in 2010, we prove the existence and convergence of minimizers of the new Landau-de Gennes energy. Moreover, we find a new way to study the limiting problem of the Landau-de Gennes system since the cross product method of Chen in 1989 on the Ginzburg-Landau equation does not work for the Landau-de Gennes system.

18.6. The Minkowski problem in the sphere

Qiang Guang (Australian National University)

Tue 8 December 202016:20

Dr Qiang Guang

The classical Minkowski problem concerns the existence of a convex body in the Euclidean space whose boundary has its Gauss curvature prescribed as a function of its normal. In this talk, we will discuss the Minkowski problem in the sphere. We prove that for any positive function on the sphere, there is a convex hypersurface in the sphere such that its Gauss curvature is equal to the given function.

18.7. More insights into the Trudinger-Moser inequality with monomial weight

Daniel Hauer (The University of Sydney)

Thu 10 December 202014:00

Dr Daniel Hauer

In this talk, I present recent results on the study of critical embeddings of weighted Sobolev spaces into weighted Orlicz spaces of exponential type for weights of monomial type. More precisely, I give an alternative proof of a recent result by N. Lam [NoDEA 24(4), 2017] showing the optimality of the constant in the Trudinger-Moser inequality. I show that the critical embedding is optimal within the class of Orlicz target spaces. Moreover, I prove that it is not compact, and derive a corresponding version of P.-L. Lions' principle of concentrated compactness.

The presented results are obtained in a joint work with Petr Gurka (University of Life Sciences, Prague)

18.8. Free boundary in optimal partial transport

Jiakun Liu (University of Wollongong)

Tue 8 December 202015:50

Dr Jiakun Liu

In this talk, we introduce some recent development of regularity results in optimal (partial) transport problems. In particular, when the densities are C^α and the domains are C^2, uniformly convex, by adopting our recent results on global regularity of Monge-Ampère equations, we prove that the free boundary is $C^{2,\alpha}$. This is a joint work with Shibing Chen (USTC) and Xu-Jia Wang (ANU).

18.9. Boundary stickiness of nonlocal minimal surfaces

Luca Lombardini (The University of Western Australia)

Wed 9 December 202013:20

Dr Luca Lombardini

The nonlocal minimal surfaces were introduced in 2010, in a seminal paper by Caffarelli, Roquejoffre and Savin, as the boundaries of those sets that minimize the so-called s-perimeter. We will give an introduction to the s-perimeter, which is, roughly speaking, the $W^{s,1}$-seminorm of the characteristic function of a set. We will explain in which sense this perimeter functional can be thought of as a fractional and nonlocal analogue of the perimeter introduced by De Giorgi and Caccioppoli. Then we will focus on the qualitative and regularity properties of the nonlocal minimal surfaces. On the one hand, when the fractional parameter s is close to 1, the s-perimeter and its minimizers are close (in an appropriate sense) to the usual perimeter and the classical minimal surfaces. On the other hand, we will show that when s is close to 0 the nonlocal character of the s-perimeter becomes more and more evident, and its minimizers exhibit some surprising, typically nonlocal, boundary behavior. Part of the results that I will present come from a joint paper with Claudia Bucur and Enrico Valdinoci.

18.10. Semi-wave, traveling wave and spreading speed for monostable cooperative systems with nonlocal diffusion and free boundaries

Wenjie Ni (University of New England)

Wed 9 December 202015:50

Dr Wenjie Ni

We consider a class of cooperative reaction-diffusion systems with free boundaries in one space dimension, where the diffusion terms are nonlocal, given by integral operators involving suitable kernel functions, and they are allowed not to appear in some of the equations in the system. The problem is monostable in nature, resembling the well known Fisher-KPP equation.

In this paper, we develop a systematic approach to determine the spreading profile of the system, and obtain threshold conditions on the kernel functions which decide exactly when the spreading has finite speed, or infinite speed (accelerated spreading).

18.11. Symmetry and stability for some problems in PDEs

Giorgio Poggesi (The University of Western Australia)

Thu 10 December 202016:00

Dr Giorgio Poggesi

Alexandrov's Soap Bubble Theorem states that a compact hypersurface embedded in $\mathbb{R}^N$ with constant mean curvature must be a sphere.

Serrin's symmetry result for the torsional rigidity states that the overdetermined boundary value problem

$$\Delta u = N \ \text{ in } \ \Omega, \quad u = 0 \ \text{ on } \ \Gamma, \quad u_\nu = R \ \text{ on } \ \Gamma,$$

admits a solution for some positive constant R if and only if Ω is a ball of radius R and, up to translations, $u(x) = (|x|^2 - R^2)/2$. Here, $\Omega \subset \mathbb{R}^N$ is a bounded domain, Γ denotes its boundary, and u_ν is the outward normal derivative of u on Γ.

In this talk, we present new elegant proofs of those two pioneering symmetry results. More precisely, we show that each of the two symmetry results can be obtained as a corollary of a single, appropriate integral identity. Then, we use those identities to obtain stability estimates for the spherical configuration.

We also deal with symmetry and stability for other related problems.

The results presented are based on the works listed below.

[1] S. Dipierro, G. Poggesi, E. Valdinoci, *A Serrin-type problem with partial knowledge of the domain*, submitted, preprint (2020) arXiv:2005.04859

[2] R. Magnanini and G. Poggesi, *On the stability for Alexandrov's Soap Bubble theorem*, J. Anal. Math., 139(1):179–205, 2019. Preprint (2016) arXiv:1610.07036

[3] R. Magnanini and G. Poggesi, *Serrin's problem and Alexandrov's Soap Bubble Theorem: enhanced stability via integral identities*, Indiana Univ. Math. J. 69 (2020), no. 4, 1181–1205. Preprint (2017) arXiv:1708.07392

[4] R. Magnanini and G. Poggesi, *Nearly optimal stability for Serrin's problem and the Soap Bubble theorem*, Calc. Var. Partial Differential Equations, 59(1):Paper No. 35, 2020. Preprint (2019) arXiv:1903.04823

[5] R. Magnanini and G. Poggesi, *An interpolating inequality for solutions of uniformly elliptic equations*, submitted, preprint (2020) arXiv:2002.04332

[6] G. Poggesi, *Radial symmetry for p-harmonic functions in exterior and punctured domains*, Appl. Anal. 98 (2019), no. 10, 1785–1798. Preprint (2018) arXiv:1801.07105

[7] G. Poggesi, *The Soap Bubble Theorem and Serrin's problem: quantitative symmetry*, PhD Thesis, defended on 18 February 2019 at Università di Firenze, preprint (2019) arXiv:1902.08584

18.12. Γ-limit for a phase transition model in magnetization

Wenhui Shi (Monash University)

Wed 9 December 202013:50

Ms Wenhui Shi

In this talk I will discuss a vectorial variant of the classical Modica-Mortola model, which naturally appears in the thin film magnetization. The model involves a competition between a diffuse interfacial energy and a nonlocal magnetostatics interaction. We show that in the macroscopic limit the energy Γ-converges to a limit energy, where the jump discontinuity of the minimizers is a minimal surface in the subcritical regime and exhibits a zigzag pattern in the supercritical regime. This is joint work with Hans Knuepfer.

18.13. Hessian estimates for Monge-Ampère type equations and applications

Neil Trudinger (Australian National University)

Tue 8 December 202014:50

Prof Neil Trudinger

In this talk we present recent interior and global, second derivative estimates for general Monge-Ampère type equations, in two and higher dimensions. We also discuss some application including the classical solvability of the second boundary value problem for prescribed Jacobian equations.

18.14. The Bernstein technique for integrodifferential equations

Enrico Valdinoci (The University of Western Australia)

Wed 9 December 202015:20

Prof Enrico Valdinoci

We present a version of the classical Bernstein technique for integrodifferential operators. We provide first and one-sided second derivative estimates for solutions to fractional equations, including some convex fully nonlinear equations of order smaller than two, for which we prove uniform estimates as their order approaches two. Our method is robust enough to be applied to some Pucci-type extremal equations and to obstacle problems for fractional operators, although several of the results are new even in the linear case. We also raise some open questions. The result discussed come from a joint work with Xavier Cabré and Serena Dipierro.

18.15. Long-time dynamics of a Diffusive Epidemic Model with Free Boundaries

Rong Wang (University of New England)

Wed 9 December 202016:50

Miss Rong Wang

In this paper, we determine the long-time dynamical behaviour of a reaction-diffusion system with free boundaries, which models the spreading of an epidemic whose moving front is represented by the free boundaries. We prove a spreading-vanishing dichotomy and determine exactly when each of the alternatives occurs. If the reproduction number r obtained from the corresponding ODE model is no larger than 1, then the epidemic modelled here will vanish, while if r¿1, then the epidemic may vanish or spread depending on its initial size, determined by the dichotomy criteria. Moreover, when spreading happens, we show that the expanding front of the epidemic has an asymptotic spreading speed, which is determined by an associated semi-wave problem.

18.16. Prescribed Gauss curvature problems

Xu-Jia Wang (Australian National University)

Thu 10 December 202013:00

Prof Xu-Jia Wang

We show that the Gauss curvature flow is an efficient tool to study several prescribed Gauss curvature problems, such as the Minkowski problem, Aleksandrov's problem, dual Minkowski problem, or more general prescribed Gauss curvature problems.

19. Probability Theory and Stochastic Processes

19.1. Ruin probabilities in the presence of risky investments and random switching

Kostya Borovkov (The University of Melbourne)

Wed 9 December 202013:20
Kostya Borovkov

We consider a reserve process where claim times form a renewal process, while between the claim times the process has the dynamics of geometric Brownian motion-type Itô processes with time-dependent random coefficients that are "reset" after each jump. Following the approach of Pergamenshchikov and Zeitoni (2006), we use the implicit renewal theory to obtain power-function bounds for the eventual ruin probability. In the special case of the gamma-distributed claim inter-arrival times and geometric Brownian motions with random coefficients, we obtain necessary and sufficient conditions for existence of Lundberg's exponent (ensuring the power function behaviour for the ruin probability). [Joint work with Roxanne He.]

19.2. Revisting stochastic calculus for point processes

Tim Brown (Monash University)

Fri 11 December 202014:00
Dr Tim Brown

Stochastic calculus for point processes has proved very useful in statistics, filtering and control, not just of point processes but of jump and other processes based on them. The fundamental tool is the compensator of the point process which formally arises from the Doob-Meyer decomposition theorem for submartingales. The compensator is just the accumulated probability of points in future small time intervals conditional on the history the past and present - a quantity which has been the subject of daily press conferences around the world during COVID19, where the points in this case are COVID19 infections, and the history includes infections from the past and current regulations for their control. It is possible to construct the compensator by direct approximation from the discrete, removing the need for references outside probability. The approximation is both intuitive and relatively simple. A direct proof of the Watanabe characterisation of the Poisson process will also be given. These ideas have roots in published and unpublished work with the most direct connection being with the MSc Thesis of Stephen Hanly at UWA in the late 80s.

19.3. Topics in Random Games

Andrea Collevecchio (Monash University)

Fri 11 December 202010:30
A/Prof Andrea Collevecchio

We consider games with random payoffs. Discuss the geometry of Nash Equilibria, and how to reach them.

19.4. Strong Law of Large Numbers for Functionals of Random Fields

Illia Donhauzer (La Trobe University)

Wed 9 December 202015:20
Mr Illia Donhauzer

Classical probabilistic results that originally were obtained for sequences of random variables require extensions to stochastic processes due to new types of observations collected as functional curves, raster images, or spatial data. The talk discusses the Strong Law of Large Numbers (SLLN) for integral functionals of random fields with unboundedly increasing covariances. The case of functional data and increasing domain asymptotics is considered. Conditions on covariance functions such that SLLN holds true will be presented. The considered scenarios include non-stationary random fields. Examples of applications to weak and long-range dependent random fields will be given.

The talk is based on joint results [1] with A.Olenko (La Trobe university, Australia) and A.Volodin (University of Regina, Canada).

[1] I. Donhauzer, A. Olenko, A. Volodin. Strong Law of Large Numbers for Functionals of Random Fields with Unboundedly Increasing Covariances, submitted.

19.5. The Asymptotics of Optimal Stopping Times

Hugh Entwistle (Macquarie University)

Wed 9 December 202013:50
Mr Hugh Entwistle

We consider problems in optimal stopping, where a sequence of n independent random variables are sequentially drawn from a known continuous distribution. The 'agent' decides to stop at a particular observation, and receives the value as their reward, or they decide to keep going until they stop further along or (possibly) they run out of observations (and must stop on the last observation). The objective is to find a stopping rule that maximizes the expected reward; this is commonly referred to as the "full information" problem. While there is extensive literature on optimal stopping problems, less attention has been devoted to the asymptotic properties of these problems - where attention has been mainly given to the "no information" problem, or require techniques that are dependent on the structure of the chosen distribution in the full information problem. We discuss a general method for computing the expected value and variance of the stopping time for more general classes of probability distributions as the number of drawn observations gets large and remark on the nature of these asymptotic expressions. We also provide some specific examples and simulation results for well known distributions.

19.6. TBA

Laurence Field (Australian National University)

Wed 9 December 202017:20
Dr Laurence Field

TBA

19.7. Stationary distribution approximations for two-island Wright-Fisher models

Han Liang Gan (The University of Waikato)

Fri 11 December 202011:00
Dr Han Liang Gan

For a finite population two-island two-allele Wright-Fisher model, we present two approximation theorems for the stationary distribution of this model with: the stationary distribution of the two-island Wright-Fisher diffusion, and the beta distribution. We show that under weak migration the (finite population) stationary distribution is well approximated by the stationary distribution of the two-island diffusion model, and under strong migration, the weighted average of the two islands is well approximated by a beta distribution. Our results are derived from a new development of Stein's method for the two-island diffusion model and existing frameworks for Stein's method for the Dirichlet distribution.

19.8. Heat equation with boundary noise

Beniamin Goldys (The University of Sydney)

Tue 8 December 202014:50
Prof Beniamin Goldys

Partial differential equations (PDEs) with boundary noise arise in many areas of applied sciences, including statistical physics and fluid dynamics. The only choice of boundary noise leading to Markovian solutions is the white noise. However, the Dirichlet problem with the white noise boundary conditions is very difficult and leads to new problems in the analysis of PDEs and the theory of stochastic processes. I will present recent progress in this problem basing on joint works with Szymon Peszat.

19.9. How accurate is the saddlepoint approximation for MLEs?

Jesse Goodman (University of Auckland)

Fri 11 December 202014:30
Dr Jesse Goodman

The saddlepoint approximation gives a systematic approximation to an unknown density function, if we have a formula for the moment generating function. When it applies, it can give surprisingly accurate results with very little computation, even uniformly over the domain. I will explain how much accuracy to expect from the saddlepoint approximation, when applied to a sum of n i.i.d. terms.

Usually this question is asked about the density, in which case a standard answer is well known. Applied to the MLE, the saddlepoint approximation turns out to be even more accurate.

19.10. Semidefinite relaxations for exit-time stochastic control

Chunxi Jiao (The University of Sydney)

Tue 8 December 202016:20

Chunxi Jiao and Reiichiro Kawai

We investigate the linear programming framework for an exit-time stochastic control problem and apply the moment-sum-of-squares hierarchy to obtain tight pointwise bounds and global bounding functions for the value function. The primal linear program over suitable measures and the dual linear program over test functions are implemented numerically by semidefinite programs which target at moments and sum-of-squares polynomial representations respectively. Numerically optimized bounds converge to the value function from below as polynomial degree increases to infinity under suitable technical conditions. We focus on the dual problem which is particularly effective as its single implementation yields a polynomial bounding function over the entire problem domain, and since it allows a flexible choice of objective function, one may improve the global bound on regions of interest.

19.11. Weighted nonlinear regression with nonstationary time series

Chunlei Jin (The University of Sydney)

Thu 10 December 202013:00

Ms Chunlei Jin

This paper investigates weighted least squares (WLS) estimation in nonlinear cointegrating regression. In nonlinear predictive regression models where the regressors include nearly integrated arrays and stationary processes, it is shown that, for a selected weight function, the WLS estimator has a mixed Gaussion limit distribution so that the corresponding studentized statistic converges to a standard normal. Such a WLS estimator has big advantages in applications since it is free of the memory parameter even when a fractional process is included in the regressors. Ordinary LS estimator has also been considered for a comparison to that of WLS estimator. As it is well-known in previous researches, the limit distribution of the ordinary LS estimator is shown to be non-Gaussion and depends on the nuisance parameters from the regressors.

19.12. New universality in stochastic systems

Fima Klebaner (Monash University)

Tue 8 December 202015:50

Prof Fima Klebaner

We give a new result on the long term behaviour of a dynamical system perturbed by small noise and started near an unstable fixed point, with an application to the Bare Bones evolution model for an establishment of a mutant.

19.13. Optimal stopping problems up to a random time horizon

Libo Li (University of New South Wales)

Fri 11 December 202015:00

Dr Libo Li

The current work is motivated by the pricing of European and American style contracts with extraneous event risk. More specifically, we study non-linear optimal stopping problems up to a random time horizon, while making minimal assumptions on the random time. The non-linear evaluation here is introduced through a backward stochastic differential equation (BSDE) and the value function of the optimal stopping problem is related to a reflected BSDE. In contrary to existing works in this area we avoid making specific assumptions on the random time and we study the existence of solutions to the reflected BSDEs and associated optimal stopping problem through reducing them to another more manageable reflected BSDE.

19.14. A remarkable invariance property for the Dickman subordi

Ross Maller (Australian National University)

Fri 11 December 202012:00

Yuguang Ipsen, Ross Maller, Soudabeh Shemehsavar

A remarkable invariance property for the Dickman subordinator Yuguang Ipsen, Ross Maller, Soudabeh Shemehsavar
The Dickman function and associated distribution play a prominent role in probabilistic number theory and in the theory of Poisson-Dirichlet distributions. These distributions in turn are closely related to properties of ordered jumps of subordinators. We present a remarkable invariance property for the Dickman subordinator which is proved in Ipsen, Maller, Shemehsavar (Stoch. Proc. Appl. 2020).

19.15. Rare-Event Simulation for Random Geometric Graphs

Sarat Babu Moka (The University of Queensland)

Thu 10 December 202016:00

Dr Sarat Babu Moka

A random geometric graph is an undirected graph, which is obtained by randomly selecting nodes on a metric space and connecting two nodes if and only if their distance is smaller than a given value. In this talk, we focus on a random geometric graph with nodes distributed as a Poisson point process. We introduce two novels Monte Carlo simulation methods, namely, conditional Monte Carlo and importance sampling-based Monte Carlo, for estimating rare-event probabilities related to the number of edges. We conduct asymptotic analysis to establish their efficacy by comparing it with the crude Monte Carlo method. We illustrate our findings with several computer simulation experiments.

19.16. Spherical Monofractal and Multifractal Random Fields with Cosmological Applications

Ravindi Nanayakkara (La Trobe University)

Wed 9 December 202016:50

Mrs Ravindi Nanayakkara

In this talk, we discuss multifractal behaviour of spherical random fields and applications to Cosmic Microwave Background (CMB) radiation data.
The main stochastic model which is used to describe the CMB data is isotropic spherical Gaussian fields. The Rényi function is one of the main tools in the analysis of multifractal random fields. For random fields on the sphere, there are only three models in the literature where the Rényi function is known explicitly. They are log-normal model, log-gamma model, and log-negative-inverse-gamma model [1]. In this presentation, we discuss some new models and approaches where the Rényi function can be computed and analysed explicitly. We show how to check moment conditions on the mother random field to guarantee the convergence of stochastic measures and specific forms of Rényi functions. For all considered random fields explicit expressions of their multifractal spectrum were obtained, see [2].
The considered mathematical models were motivated by investigations of CMB which is the radiation from the universe since 380,000 years from the Big Bang. We use data from the space mission Planck by the European Space Agency. One of the aims of this mission was to verify the standard model of cosmology using a very detailed resolution of observations and to find out fluctuations from this model. We present numerical multifractality studies and methodology for computing the Rényi function and the multifractal spectrum of the CMB data.
The obtained results can also find numerous potential applications for stochastic modelling and analysis of other geoscience, environmental and directional data.
The talk is based on joint results [2] with Professors Nikolai Leonenko (Cardiff University, UK) and Andriy Olenko (La Trobe University, Australia).

Keywords: Rényi Function, Random Field, Multifractality, Monofractality, Cosmic Microwave Background Radiation

References

(1) Leonenko, N. & Shieh, N.R. (2013). Rényi function for multifractal random fields. Fractals, 21(2), 1350009.

(2) Leonenko, N., Nanayakkara, R., & Olenko, A. (2020). Analysis of Spherical Monofractal and Multifractal Random Fields. Stochastic Environmental Research and Risk Assessment Journal. https://doi.org/10.1007/s00477-020-01911-z

19.17. Matrix-Analytic Methods for the analysis of Stochastic Fluid-Fluid Models

Malgorzata Marzena O'Reilly (University of Tasmania)

Thu 10 December 202013:30
Assoc Prof Malgorzata Marzena O'Reilly

Stochastic fluid-fluid models (SFFMs) offer powerful modeling ability for a wide range of real-life systems. The existing theoretical framework for this class of models is in terms of operator-analytic methods. For the first time, we establish matrix-analytic methods for the effcient analysis of SFFMs.

19.18. On the running maxima of φ-subgaussian random fields

Andriy Olenko (La Trobe University)

Thu 10 December 202015:30
Dr Andriy Olenko

In this talk we will discuss the running maxima

$$Y_{m,j} = \max_{1 \le k \le m, 1 \le n \le j} X_{k,n} - a_{m,j},$$

where $\{X_{k,n}, k \ge 1, n \ge 1\}$ is a random double array (a random field defined on the integer lattice) of φ-subgaussian random variables and $\{a_{m,j}, m \ge 1, j \ge 1\}$ is a double array of constants to be specified. The concept of φ-subgaussianity was introduced and studied in the monograph [1].

We obtain the asymptotic behaviour of the running maxima of the double arrays of positive and negative parts of $\{Y_{m,j}, m \ge 1, j \ge 1\}$ when the tail distributions of $\{X_{k,n}, k \ge 1, n \ge 1\}$ satisfies some suitable "exponential-type" conditions.

The talk is based on joint results with I. Donhauzer (La Trobe university, Australia), R. Giuliano (Università di Pisa, Italy) and A. Volodin(University of Regina, Canada).

[1] Buldygin, V.V., Kozachenko Yu.V. (2000) Metric Characterization of Random Variables and Random Processes. American Mathematical Society, Providence RI.

19.19. Rate of strong convergence to solutions of regime-switching stochastic differential equations

Oscar Peralta (The University of Adelaide)

Thu 10 December 202014:00
Dr Oscar Peralta

Regime-switching stochastic differential equations (RSSDE) have been recently used to model random diffusive phenomena which are further affected by some finite-state random environment. In this talk we tackle the following: given a family of finite-variation processes $\{F^\lambda\}_{\lambda \ge 0}$ that converge strongly to a standard Brownian motion B as $\lambda \to \infty$, do the solutions of the RSSDEs associated to $\{F^\lambda\}_{\lambda \ge 0}$ converge strongly to the solution of the RSSDE associated to B? Following a Wong-Zakai approach together with a pathwise construction of the solutions via the Lamperti transform, we answer this question positively under fairly general conditions on the regime-switching mechanism. Moreover, we prove that the rate of convergence of the solutions is comparable to that of $\{F^\lambda\}_{\lambda \ge 0}$ to B.

19.20. High-density limits for infinite occupancy processes

Philip Keith Pollett (University of Queensland)

Thu 10 December 202015:00
Prof Philip Keith Pollett

We consider a class of stochastic occupancy processes where there is no ceiling on the number of sites that can be occupied. We examine the limiting behaviour as the density of sites in space increases. These limits are not only natural in the theory, but in practice as well, as they describe models with increasing environmental fidelity.

This is joint work with Liam Hodgkinson

19.21. Hidden Equations of Threshold Risk

ZHIHAO QIAO (The University of Queensland)

Wed 9 December 202012:50

Jerzy A. Filar, Vladimir Ejov and ZHIHAO QIAO

We consider the problem of sensitivity of threshold risk, defined as the probability of a function of a random variable falling below a specified threshold level $\delta > 0$. We demonstrate that for polynomial and rational functions of that random variable there exist at most finitely many risk critical points. The latter are those special values of the threshold parameter for which rate of change of risk is unbounded as δ approaches these threshold values. We characterize candidates for risk critical points as zeroes of either the resultant of a relevant $\delta-$perturbed polynomial, or of its leading coefficient, or both. Thus the equations that need to be solved are themselves polynomial equations in δ that exploit the algebraic properties of the underlying polynomial or rational functions. We name these important equations as "hidden equations of threshold risk".

19.22. Uniformization-stable Markov models

Jeremy Sumner (University of Tasmania)

Fri 11 December 202012:30

Dr Jeremy Sumner

I will discuss the algebraic structure underlying uniformization of continuous-time Markov chains. In particular, I will present recent work which establishes that linear Markov models are "uniformization-stable" if and only if their associated rate matrices occur precisely as the intersection with a Jordan algebra. I will show that this algebraic perspective gives a unified view of this phenomenon spanning disparate model families, including, in particular, the time-reversible hierarchy.

This is joint work with Luke Cooper.

19.23. Safe Blues

Peter Taylor (The University of Melbourne)

Wed 9 December 202014:50

Prof Peter Taylor

Viral spread is a complicated function of multiple elements including biological properties, the environment, preventative measures such as sanitation and masks, and the rate at which individuals come within physical proximity. It is these last two elements that governments can control through social-distancing directives. However, with a pandemic such as COVID-19, the data is always lagging since the time between a patient being infected with SARS-CoV-2 and being recorded as positive can be a week or more. Consequently, there can be a time lag of the order of several weeks between the initiation of a regulatory measure and its observed effect.

Safe Blues is one way of addressing the problem caused by this time lag, providing real time population-level estimates of an epidemic's response to government directives and near-future projections of the epidemic. Safe Blues strands are safe virtual 'virus-like' tokens that respond to social-distancing directives in a manner similar to the actual virus. However, they are spread using cellular devices and Bluetooth. The relationship between counts of multiple forms of the tokens and the progress of the actual epidemic can be determined using machine learning techniques applied to delayed measurements. This then allows real-time data on the Safe Blues tokens to be used to estimate the current state of the epidemic and provide more accurate projections about its near-future progress.

The Safe Blues protocol and machine learning techniques have been developed together with an experimental minimal viable product, presented as an app on Android devices with a server back-end. Following initial exploration via simulation experiments, we are now preparing for a university-wide experiment of Safe Blues.

19.24. Asymptotic Behavior of a Critical Fluid Model for Bandwidth Sharing with General File Size Distributions

Ruth J Williams (UC San Diego)

Fri 11 December 202010:00

Yingjia Fu and Ruth J Williams

This work concerns the asymptotic behavior of solutions to a critical fluid model for a data communication network, where file sizes are generally distributed and the network operates under an alpha-fair

bandwidth sharing policy. We introduce a new Lyapunov function. Using this, under moderate conditions on the file size distributions, we prove that critical fluid model solutions converge uniformly to the set of invariant states as time goes to infinity, when started in suitable relatively compact sets.

19.25. When does massive-data bootstrap work?

Nan Zou (Macquarie University)

Wed 9 December 202015:50

Patrice Bertail, Dimitris Politis, Stanislav Volgushev, and Nan Zou

In classic statistical inference, the bootstrap stands out as a simple, powerful, and data-driven technique. However, when coping with massive data sets, which are increasingly prevalent these days, the bootstrap can be computationally infeasible. To speed up the bootstrap for massive data sets, the "bag of little bootstraps" has been invented in 2012. Despite its considerable popularity, little is known about bag of little bootstraps's theoretical properties, including reliability. Indeed, my preliminary results have already raised questions on the applicability of the bag of little bootstraps under some simple but important settings.

In this talk, we will first introduce the bootstrap and the bag of little bootstraps procedures and will then launch a theoretical investigation for the latter. Specifically, for the applicability of the bag of little bootstraps, we will unveil a counterexample for the claimed sufficient condition in the literature and will, as a remedy, offer a correct, generic sufficient condition. This work is joint with P. Bertail, D. Politis, and S. Volgushev.

20. Representation Theory

20.1. p-Kazhdan-Lusztig polynomials for (co)minuscule flag varieties

Joseph Baine (The University of Sydney)

Tue 8 December 202014:50

Mr Joseph Baine

p-Kazhdan-Lusztig theory has revolutionised modular representation theory. However, it is considerably more difficult to compute than classical Kazhdan-Lusztig theory. Minuscule and cominuscule flag varieties are families of objects with relatively simple Kazhdan-Lusztig bases. One might hope this simplicity generalises to the modular setting; fortunately it does. In this talk we will compute the p-Kazhdan-Lusztig bases of the antispherical and spherical modules (with mild assumptions on characteristic in the latter case) associated to (co)minuscule flag varieties. As an application we use recent results of Achar-Riche and Riche-Williamson to derive characters of simple modules and tilting modules for algebraic groups in prime characteristic.

20.2. Topology and geometry of representation varieties via point counting

Nick Bridger (University of Queensland)

Wed 9 December 202015:50

Mr Nick Bridger

Representation varieties have been studied for over thirty years and is a vibrant topic of current research. The topology and geometry of these varieties remain very elusive. Remarkably, we can understand a lot about the representation variety by counting its points over finite fields. A key input for this calculation is a Frobenius-like formula which describes its number of $\mathbb{F}_q$-points in terms of the irreducible complex characters of a finite reductive group. If this number always turns out to be a polynomial in q then this determines the E-polynomial (aka Deligne-Serre polynomial) of the representation variety. In this talk we will explore these ideas deeper and discuss the interesting topological information that we can obtain in this way.

20.3. Subregular elliptic slices and deformations of singularities

Dougal Davis (University of Edinburgh)

Thu 10 December 202013:30
Dr Dougal Davis

Let G be a simply connected simple algebraic group and let Bun_G be the stack of principal G-bundles over an elliptic curve E. In this talk, I will explain how to construct singular surfaces and parts of their miniversal deformations by taking slices of Bun_G through subregular unstable bundles. This construction can be viewed as an elliptic analogue of the classical fact that the restriction of the adjoint quotient map of the Lie algebra of G to a subregular Slodowy slice S gives a miniversal deformation of the intersection of S with the nilpotent cone. If time permits (which it almost certainly will not), I will also touch on the combinatorics of folding in this context and on questions of Poisson geometry and quantisation.

20.4. The regular representations of quantum linear and queer supergroups

Jie Du (University of New South Wales)

Thu 10 December 202016:00
Prof Jie Du

Using quantum differential operators, we construct two super representations for the quantum linear and queer supergroups on certain polynomial superalgebras. We then extend each of the representations to its formal power series algebra which contains a submodule isomorphic to the regular representation of the supergroup. In this way, we obtain a new presentation of the supergroup by a basis together with explicit multiplication formulas of the basis elements by generators. This is joint works with Z. Zhou and with Y. Lin and Z. Zhou.

20.5. Jacobson-Morozov Lemma for Lie superalgebras using semisimplification

Inna Entova-Aizenbud (Ben Gurion University)

Wed 9 December 202016:50
Dr Inna Entova-Aizenbud

I will present a generalization of the Jacobson-Morozov Lemma for quasi-reductive algebraic supergroups (respectively, Lie superalgebras), based on the idea of semisimplification of tensor categories, which will be explained during the talk. This is a joint project with V. Serganova.

20.6. Braid groups of normalizers of reflection subgroups

Anthony Henderson (The University of Sydney)

Thu 10 December 202016:30
Prof Anthony Henderson

Various results are known about the normalizers of reflection subgroups in a complex reflection group. At the most basic level, in certain situations it is known that the normalizer is a semidirect product of the reflection subgroup and a complementary subgroup. Ivan Marin gave a topological definition of a group which could be thought of as the braid group of such a normalizer, and raised the question of whether it has a similar semidirect product decomposition. In joint work with Thomas Gobet and Ivan Marin, we show that this holds in the Coxeter case but not in general.

20.7. Categorifying Burau representations and categorical dynamics

Edmund Xian Chen Heng (Australian National University)

Wed 9 December 202012:50
Edmund Heng

In this talk, I will describe a construction of algebra objects in some monoidal categories, which allows one to categorify the Burau representations of (non-simply laced type) generalised braid groups. This categorification opens the door to study the dynamics of generalised braid groups through categorical dynamics, similar to the study of dynamics of standard braid groups by viewing it as mapping class groups of some punctured disks. Parallel to the theory of train-tracks by Bestvina-Handel, I will show that the categorical entropies can be computed from the Perron-Frobenius eigenvalues of certain matrices obtained through stability conditions closely related to the root systems.

20.8. Cellular structures of the Temperley-Lieb algebra

Mengfan Lyu (The University of Sydney)

Wed 9 December 202015:20

Mr Mengfan Lyu

It is well-known that a Temperley-Lieb algebra $TL_n(q)$ can be regarded as a quotient of the corresponding Heck algebra $H_n(q)$. Graham and Lehrer showed that both of them are cellular. A natural question is whether there is any connection between these two cellular structures. The answer is yes. We construct a concrete map which implies that the cellular structure of a Temperley-Lieb algebra of type A or B can be regarded as a truncation of the corresponding Hecke algebra. This map also gives us a clue to the cellular structure of the generalized blob algebra.

20.9. Categorification via modular representations of sl_n, and Lusztig's conjectures

Vinoth Nandakumar (The University of Sydney)

Thu 10 December 202014:30

Vinoth Nandakumar, Gufang Zhao

Classical results of Bernstein, Frenkel, Khovanov constructed one of the first examples of sl_2 categorifications using singular blocks of category O for sl_m and translation functors. This implies that the Kazhdan-Lusztig conjectures can be reformulated using canonical bases in tensor products of quantum group representations. Here we discuss a positive characteristic analogue of this story. Using blocks of representations of sl_m in positive characteristic, with nilpotent Frobenius character and singular Harish-Chandra character, we obtain categorifications of sl_2 tensor product representations (cf. Chuang-Rouquier). These are equivalent to a geometric categorification constructed by Cautis, Kamnitzer and Licata (via localization theory in positive characteristic). As a byproduct, this leads us to a reformulation of Lusztig's conjecture in this setting via canonical bases in representations of the quantum affine algebra. This is joint work with Gufang Zhao.

20.10. Double affine Hecke algebras and the Bruhat order

Anna Puskas (The University of Queensland)

Thu 10 December 202015:30

Dr Anna Puskas

The Iwahori-Hecke algebra is a fundamental tool in the representation theory of p-adic groups.

We will discuss how the features of a "Tits cone" double affine Hecke algebra, introduced by Braverman, Kazhdan and Patnaik, differs from the Coxeter and Bernstein presentation of the affine Iwahori-Hecke algebra. We will discuss features of these algebras, and present some conjectures in the double affine context. This is joint work in progress with Dinakar Muthiah.

20.11. Extremal weight modules, global Weyl modules and local Weyl modules

Arun Ram (The University of Melbourne)

Wed 9 December 202016:20

Prof Arun Ram

This talk will be a brief review of the indexing and structure of level 0 standard modules for affine Lie algebras. Basically, the extremal weight modules are shaped like infinite tubes, and the local Weyl modules have the shape of the torus obtain by gluing the ends of the tube together. The Heisenberg subalgebra inside the affine Lie algebra moves vectors up and down the tube.

20.12. Character formulas for representations of reductive algebraic groups in positive characteristic

Simon Riche (Université Clermont Auvergne)

Tue 8 December 202015:50

Prof Simon Riche

A central question in representation theory of reductive algebraic groups (over fields of positive characteristic) is that of computing characters of various families of representations, and in particular simple ones. Lusztig's conjecture gives an answer to this problem, which is known to be correct if the characteristic of the base field is large enough, but recent work of G. Williamson shows that this formula does *not* hold under reasonable assumptions. In this talk I will explain a new approach to this problem proposed in joint work with Geordie Williamson, involving the "p-canonical basis" of the associated affine Weyl group, and a recent proof of a character formula for tilting representations obtained in joint work with Roman Bezrukavnikov.

20.13. Minimal reflection subgroups containing Sylow subgroups

Kane Townsend (The University of Sydney)

Wed 9 December 202013:20

Mr Kane Townsend

We will discuss how to classify up to conjugacy the reflection subgroups minimally containing Sylow subgroups of finite complex reflection groups. This classification gives us a short list of complex reflection groups that if we describe their Sylow subgroups, we can deduce the Sylow subgroups of all complex reflection groups. We will then look at how this applies to a result by Michel Enguehard and Jean Michel regarding Sylow subgroups of finite reductive groups.

20.14. Heisenberg categorification in positive characteristic

Giulian Wiggins (The University of Sydney)

Wed 9 December 202013:50

Mr Giulian Wiggins

Licata-Savage (2013), quantizing a result of Khovanov, define a category of planar diagrams (called the Heisenberg category) that acts on the categories of modules for Hecke algebras in type A in characteristic zero. From this they obtain a categorification of Fock space representation of the Heisenberg algebra.

We study actions of the Heisenberg category in arbitrary characteristic. We present a general construction to provide (not necessarily exact) functors lifting the Heisenberg relations. We discuss criteria for these functors to be exact, and hence descend to an action of the Heisenberg algebra on the Grothendieck group.

This is joint work with Jiuzu Hong and Oded Yacobi.

20.15. Curve complexes in topology and triangulated categories

Sinead Wilson (The Australian National University)

Tue 8 December 202015:20

Ms Sinead Wilson

To any surface S one can associate a simplicial complex, called the curve complex, consisting of homotopy classes of essential closed curves on S. It is closely related to the geometry of the Teichmueller space of S. An important theorem of Masur and Minsky states that the curve complex is hyperbolic. In this talk I will discuss the Masur-Minsky Theorem, and my ongoing work towards an analogue in the context of triangulated categories.

20.16. Noncrossing algebras and Milnor fibres of reflection arrangements

Yang Zhang (The University of Sydney)

Thu 10 December 202014:00

Dr Yang Zhang

For any finite Coxeter group there is a noncrossing partition (NCP) lattice comprising elements between the identity and a fixed Coxeter element. In analogy with the Orlik-Solomon algebra, I will define a finite dimensional $\mathbb{Z}$-graded algebra, called noncrossing algebra, associated to any NCP lattice in two different ways. Each graded component of this algebra is isomorphic to the direct sum of all homology of order complexes of lower intervals of a fixed rank. In terms of this algebra, I will give an explicit finite chain complex of free abelian groups whose homology is the integral homology of the Milnor fibre of the corresponding Coxeter arrangement. This permits us to calculate the homology of Milnor fibres computationally. The actions of both W and the monodromy can be partly described by our chain complex. Time permitting, I will talk about connections with the integral homology of braid groups and pure braid groups.

21. Topology

21.1. Immersed flat ribbon knots

José Ayala Hoffmann (The University of Melbourne)

Thu 10 December 202014:00

Dr José Ayala Hoffmann

We study the minimum ribbonlength for immersed planar ribbon knots and links. Our approach is to embed the space of such knots and links into a larger more tractable space of disk diagrams. When length minimisers in disk diagram space are ribbon, then these solve the ribbonlength problem. We provide examples when minimisers in the space of disk diagrams are not ribbon and state some conjectures. We compute the minimal ribbonlength of some small knot and link diagrams and certain infinite families of link diagrams.

21.2. All closed orientable 3-manifolds are central in trisections of 5-manifolds

Carol Badre (The University of Sydney)

Tue 8 December 202015:20

Ms Carol Badre

Gay and Kirby generalised the notion of Heegaard splittings to the trisections of smooth 4-manifolds, which was subsequently generalised to the trisections of piecewise-linear 5-manifolds M by Rubinstein and Tillmann. The construction of Rubinstein and Tillmann takes advantage of a natural colouring on the vertices of particular triangulations of M inherited from a piecewise-linear map $\phi : M \to \Delta$ where Δ is a 2-simplex.

An object of interest which is a consequence of this construction is the central submanifold, which is obtained as the preimage $\phi^{-1}(b)$ of the barycentre b of Δ. Each 5-simplex of M contains a 3-cube of the central submanifold. We present a reversal of this process by first constructing a cubing of every closed orientable 3-manifold as a cyclic branched cover of S^3 over the Borromean rings and show that they are central submanifolds of trisections of piecewise-linear 5-manifolds.

This is joint work with Stephan Tillmann.

21.3. The derivate map for diffeomorphisms of discs

Diarmuid Crowley (The University of Melbourne)

Fri 11 December 202011:00

Mx Diarmuid Crowley

The derivative map $d : \mathrm{Diff}_\nabla(D^k) \to \Omega^k SO_k$ sends a diffeomorphism f of the k-disc, which is the identity near the boundary, to the map which assigns the derivative of f at x to the point $x \in D^k$.

In this talk we show that this map is in general non-zero on homotopy groups, something which has not been seen before.

The proof relies on a recent result of Burklund and Senger about certain exotic 17-spheres. This is part of joint work with Thomas Schick and Wolfgang Steimle.

21.4. Over-then-under Tangles

Zsuzsanna Dancso (The University of Sydney)

Thu 10 December 202016:30

Dr Zsuzsanna Dancso - with D. Bar-Natan and R. Van der Veen

Over-then-under (OU) tangles are oriented tangles which can be represented by a tangle diagram in which each strand travels through only under-crossings first, then only over-corssings. In a sense, these tangles are furthest from being alternating. One can use simple steps called "glide moves" to find an OU representative for tangle diagrams which have one. In this talk we characterise OU tangles, leading to separating braid invariants in classical and virtual settings. Based on a joint preprint with Dror Bar-Natan and Roland van der Veen: https://arxiv.org/abs/2007.09828

21.5. Morton's Conjecture About Lorenz Knots

Thiago de Paiva Souza (Monash University)

Tue 8 December 202015:50

Mr Thiago de Paiva

Lorenz links are a family of links that appear in the flow of the Lorenz system.

Birman and Williams showed that the satellite knots obtained as certain cables of Lorenz knots are Lorenz knots. This was extended by El-Rifai, who showed that the only way in which a Lorenz knot can be presented as the satellite of a Lorenz knot is if it is a cable on a Lorenz knot, possibly with additional twisting. Then, Morton conjectured: every Lorenz knot that is a satellite is a cable on a Lorenz knot.

In this talk , we show that as stated, this conjecture is false, by constructing infinitely many examples of Lorenz knots that are satellites but are not cables on Lorenz knots.

We will work with Lorenz links from the point of view of T-links, as introduced by Birman and Kofman.

21.6. A Thurston compactification for ... categories

Anand Rajendra Deopurkar (Australian National University)

Wed 9 December 202014:20

Dr Asilata Bapat, Dr Anand Rajendra Deopurkar, Dr Anthony Michael Licata

There is a fascinating parallel between curves on a surface and objects in a (triangulated) category that allows us to transfer intuition, techniques, and sometimes theorems between two seemingly distant worlds. I will explain a construction (joint with Asilata Bapat and Tony Licata) of a "Thurston compactification" of a categorical analogue of the Teichmuller space, the space of Bridgeland stability conditions. We expect the categorical Thurston compactification to play a key role in understanding symmetry groups of categories, similar to its role in understanding the mapping class group in geometry. I will end by highlighting features on both sides (geometric/categorical) whose analogue on the other side still eludes us.

21.7. The structure and geometry of double Hurwitz numbers

Norman Do (Monash University)

Fri 11 December 202010:00

Dr Norman Do

Double Hurwitz numbers enumerate branched covers of the sphere with prescribed ramification over two points and simple ramification elsewhere. In contrast to the single case, their underlying geometry is not yet well understood. In this talk, I will report on some recent work with Gaetan Borot, Max Karev, Danilo Lewanski and Ellena Moskovsky, in which we prove a deep structural result underlying the enumeration. This then leads to two important corollaries concerning double Hurwitz numbers. The first is that they are governed by the so-called topological recursion and the second is that they can be expressed as intersection numbers on moduli spaces of curves.

21.8. Basic properties of maps tamed by a differential form

Urs Fuchs (Monash University)

Fri 11 December 202010:30

Mr Urs Fuchs

Many classes of interesting maps between manifolds are (locally) tamed by certain differential forms. Examples include (quasi-)conformal maps, holomorphic curves and Yang-Mills instantons. I will start by saying what it means for a map to be tamed and then review how some geometric and analytic properties familiar in the above examples actually hold in a suitable form for arbitrary tamed maps.

21.9. Geometric triangulations and highly twisted links

Sophie Ham (Monash University)

Thu 10 December 202013:30

Ms Sophie Ham

It is conjectured that every cusped hyperbolic 3-manifold admits a geometric triangulation, i.e. it is decomposed into positive volume ideal hyperbolic tetrahedra. In this talk, we prove that sufficiently highly twisted knots admit a geometric triangulation. In addition, by extending work of Gueritaud and Schleimer, we also give quantified versions of this result for infinite families of examples.

21.10. Symmetries of trivalent tangles: Approaching the link between Drinfeld associators and Kashiwara-Vergne solutions

Tamara Hogan (The University of Melbourne)

Tue 8 December 202016:20

Ms Tamara Hogan

The Kashiwara-Vergne problem asks if we can give a nice presentation of the formula for $e^X e^Y$ in non-commuative settings. In practice, these nice presentations are hard to find and often arise from mysterious objects in quantum algebra called Drinfeld associators. A w-tangle is a embedding of a surface in four-space. It is a result of Bar-Natan and Dancso that universal finite type invariants are in one-to-one correspondence with Kashiwara-Vergne solutions. At the same time, Drinfeld associators are in one-to-one correspondence with universal finite type invariants of classical tangles. This project aims to explore the relationship between the Kashiwara-Vergne solutions and Drinfeld associators by looking at the corresponding relationship between classical knot theory and four dimensional knot theory.

In this talk we will describe a sub-set of w-tangles, which we call trivalent tangles, and identify their group of symmetries with the famous Grothendieck-Teichmüller group. This group is known to be the group of symmetries of Drinfeld associators and thus this gives us a knot theoretic interpretation of the Kashiwara-Vergne solutions that arise from associators.

We aim to define as many objects as possible and illustrate our constructions with many pictures.

21.11. Gluing Contact Manifolds via Foliated Open Books

Joan Licata (Australian National University)

Thu 10 December 202013:00

Dr Joan Licata

Foliated Open Books offer an intuitive cut-and-paste tool for studying contact manifolds. Open book decompositions of various flavours have been a key tool in the program of studying geometric structures on three-manifolds via topological decompositions, and we extend this to a new class of manifolds with boundary. We use foliated open books to define a contact invariant in bordered sutured Floer homology. This talk will have lots of pictures, few precise statements, and enough arXiv references to satisfy those looking for more. (joint with Alishahi, Foldvari,Hendricks, Petkova, and Vertesi)

21.12. Ptolemy vs Thurston in hyperbolic geometry and topology

Daniel Mathews (Monash University)

Wed 9 December 202015:20

Dr Daniel Mathews

Bill Thurston (1946-2012 CE) developed a system of great simplicity and power for understanding hyperbolic 3-manifolds. In particular, he introduced equations whose variables encode the shapes of ideal hyperbolic tetrahedra and whose solutions describe hyperbolic structures on 3-manifolds.

Claudius Ptolemy (c.100-170 CE), better known for developing a rather different system, proved in his Almagest an equation about the lengths of sides and diagonals in a cyclic quadrilateral. Such Ptolemy equations arise in numerous places across mathematics, including in 3-dimensional hyperbolic geometry and representation theory.

In this talk I'll discuss how Ptolemy and Thurston equations provide complementary perspectives on hyperbolic geometry and topology.

21.13. Fully simple maps and topological recursion

Ellena Moskovsky (Monash University)

Wed 9 December 202013:20

Miss Ellena Moskovsky

An ordinary map is an embedding of a graph on a surface such that the complement of the graph is a disjoint union of disks. The enumeration of ordinary maps is one of the prototypical examples of a combinatorial enumeration satisfying a particular recursion called topological recursion (TR). On the other hand, a fully simple map is a certain type of ordinary map where we add a constraint on face incidences. It has been conjectured that ordinary maps and fully simple maps are related via a certain symplectic transformation of the TR input data, implying that fully simple maps also satisfy TR. In this talk, we will discuss this relation between ordinary and fully simple maps, as well as recent joint work-in-progress with Norman Do towards a proof of the conjecture that fully simple maps too are governed by TR.

21.14. Deformations of curves in symplectic surfaces

Paul Norbury (The University of Melbourne)

Thu 10 December 202015:30

Prof Paul Norbury

An embedded curve in a symplectic surface $\Sigma \subset X$ defines a smooth deformation space $\mathcal{B}$ of nearby embedded curves. In this talk we will describe a key idea of Kontsevich and Soibelman to equip the symplectic surface X with a foliation in order to study the deformation space $\mathcal{B}$. The foliation, together with a vector space V_Σ of meromorphic differentials on Σ, endows an embedded curve Σ with the structure of the initial data of topological recursion, which defines a collection of symmetric tensors on V_Σ. In this talk we will construct a formal series out of these tensors, which turns out to be a formal Seiberg-Witten differential, that descends under a quotient to an analytic series.

21.15. A homotopy associative model for the 2D cobordism category

Marcy Robertson (The University of Melbourne)

Tue 8 December 202014:50

Dr Marcy Robertson

Gluing surfaces along their boundaries allows to define composition laws that have been used to define cobordism categories, as well as operads and props associated to surfaces. These have played an important role in recent years, for example in constructing topological field theory or computing the homology of the moduli space of Riemann surfaces. Of particular interest is the cobordism category whose morphism spaces are moduli spaces of Riemann surfaces. The composition of moduli spaces is associative on the associated chain complex, but it is not associative on the space level, and, up until now, it was not known how to make it associative, or even coherently homotopy associative. In this talk we discuss work in progress which uses a new formalism for ∞-props to give a homotopy associative model of the 2D cobordism category. This is joint work with L. Basualdo Bonatto, S. Chettih, A. Linton, S. Raynor, and N. Wahl.

21.16. Minimality Properties of the Family $\mathcal{T}_{\mathcal{R}}^{p}$ in Relator Spaces

Muwafaq Mahdi Salih (University of Debrecen)

Wed 9 December 202016:20

Mr Muwafaq Mahdi Salih

A family $\mathcal{R}$ of relations on a set X is called a relator on X, and the ordered pair $X(\mathcal{R}) = (X, \mathcal{R})$ is called a relator space. Relator spaces of this simpler type are already substantial generalizations of not only ordered sets and uniform spaces, but also topological, closure and proximity spaces.

As it is usual, for any $x \in X$ and $A \subseteq X$, we write

(1) $x \in \operatorname{int}_{\mathcal{R}}(A)$ if $R(x) \subseteq A$ for some $R \in \mathcal{R}$,

(2) $x \in \operatorname{cl}_{\mathcal{R}}(A)$ if $R(x) \cap A \neq \emptyset$ for all $R \in \mathcal{R}$.

Moreover, we may also naturally define

(3) $\mathcal{T}_{\mathcal{R}} = \left\{ A \subseteq X : A \subseteq \operatorname{int}_{\mathcal{R}}(A) \right\}$,

(4) $\mathcal{T}_{\mathcal{R}}^{p} = \left\{ A \subseteq X : A \subseteq \operatorname{int}_{\mathcal{R}}\left(\operatorname{cl}_{\mathcal{R}}(A) \right) \right\}$.

The following definition has been mainly suggested by the papers of Reilly and Vamanamuthy [**4**], Mukharjee and Roy [**3**], and Salih and Száz [**5**].

A relator $\mathcal{R}$ on X, will be called

(1) *p–minimal* if $\mathcal{T}_{\mathcal{R}}^{p} \subseteq \{\emptyset, X\}$;

(2) *relatively p–minimal* if $\mathcal{T}_{\mathcal{R}}^{p} \subseteq \mathcal{T}_{\mathcal{R}}$.

We prove that the following counterparts of [**4**] of Reilly and Vamanamuthy and [**3**] of Mukharjee and Roy. If $\mathcal{R}$ is a quasi-topologically door relator on X, then $\mathcal{R}$ is relatively p–minimal. Moreover, if $\mathcal{R}$ is a nonvoid, relatively p–minimal relator on X, then $\mathcal{R}$ is quasi-topologically submaximal. In addition to the last results we also prove that if $\mathcal{R}$ is a topologically filtered, quasi-topologically submaximal, topological relator on X, then $\mathcal{R}$ is relatively p–minimal.

The above results are under publication in a joint paper with Themistocles M. Rassias and Árpád Száz.

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21.17. The complexity of manifolds

Jonathan Spreer (The University of Sydney)
Wed 9 December 202012:50
Dr Jonathan Spreer

Manifolds are often presented in the form of a triangulation, i.e., as a decomposition of the manifold into simplices, glued along their faces. This enables us to use discrete, algorithmic methods to study topological properties of manifolds – a tremendous advantage. But it also comes with the caveat that every manifold can be presented as a triangulation in infinitely many ways.

In this talk I will focus on a very natural question: among all the triangulations of a manifold, which one uses the smallest number of top-dimensional simplices? This is known as the complexity of a manifold – and depends on the type of triangulation in use. For instance, in dimension 2, for generalised triangulations of orientable surfaces of genus $g > 0$, this number is known to be $4g - 2$. But already in dimension 3 the complexity of a manifold is typically unknown.

I will talk about common methods to determine the complexity of a manifold (or a bound thereof) in various settings spanning multiple types of triangulations and dimensions.

21.18. Constructing geometrically convergent knot complements

John Etienne Stewart (Monash University)
Wed 9 December 202013:50
Mr John Etienne Stewart

Sequences of knot complements were known to exist which converge geometrically to infinite volume hyperbolic 3-manifolds. However, these were not constructive. In this talk I outline a method for constructing finite volume hyperbolic 3-manifolds in the form of knot complements which converge geometrically to specified infinite volume hyperbolic 3-manifolds.

21.19. An action of the Polishchuk differential operator via punctured surfaces

Mehdi Tavakol (The University of Melbourne)
Thu 10 December 202016:00
Dr Mehdi Tavakol

For a family of Jacobians of smooth pointed curves, there is a notion of tautological algebra. There is an action of sl_2 on this algebra. We define and study a lifting of the Polishchuk operator on an algebra consisting of punctured Riemann surfaces. As an application, we compare a class of tautological relations on moduli of curves, discovered by Faber and Zagier and relations on the universal Jacobian. We prove that the so called top Faber-Zagier relations come from a class of relations on the Jacobian side.

21.20. A-polynomials of knots related by Dehn filling

Emily Thompson (Monash University)

Wed 9 December 202015:50
Ms Emily Thompson

The A-polynomial is a knot invariant originally defined in 1994 by Cooper et al. via representations of the knot group. The A-polynomial is known for many simple knots as well as some infinite families of knots; however, it remains difficult to compute in general. Earlier this year, Howie, Mathews and Purcell applied results of both Champanerkar and Dimofte to calculate A-polynomials for knots that arise from Dehn filling. They observed behaviour similar to that appearing in the study of cluster algebras. In this talk, we show how this cluster algebra structure leads to simplified calculations of the A-polynomial for infinitely many families of knots related by Dehn filling.

21.21. The space of properly-convex structures

Stephan Tillmann (The University of Sydney)

Wed 9 December 202016:50
Prof Stephan Tillmann

I will outline joint work with Daryl Cooper concerning the space of holonomies of properly convex real projective structures on manifolds whose fundamental group satisfies a few natural properties. This generalises previous work by Benoist for closed manifolds. A key example, computed with Joan Porti, is used to illustrate the main results.

21.22. Wasserstein stability for persistence diagrams

Katharine Turner (Australian National University)

Thu 10 December 202014:30
Dr Katharine Turner

The stability of persistence diagrams is among the most important results in applied and computational topology. Most results in the literature phrase stability in terms of the bottleneck distance between diagrams and the ∞-norm of perturbations. This has two main implications: it makes the space of persistence diagrams rather pathological and it is often provides very pessimistic bounds with respect to outliers. In this talk I will discuss new stability results with respect to the p-Wasserstein distance between persistence diagrams. I will give an elementary proof for the setting of functions on sufficiently finite spaces in terms of the p-norm of the perturbations. This is joint work with Primoz Skraba (see https://arxiv.org/abs/2006.16824).

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