The University Of Queensland
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AustMS 2023

67th Annual Meeting of the
Australian Mathematical Society

Program and Abstracts

AustMS 2023
sponsored by

Optiver

The University of Sydney
Mathematical Research Institute

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Contents

Conference Overview

AustMS2023 Organisation

Program Committee

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Jack Hall (U of Melbourne)
Nalini Joshi (U of Sydney)
Finnur Larusson (U of Adelaide)
Joan Licata (ANU)
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Malwina Luczak (U of Melbourne)
Artem Pulemotov (UQ)
Tony Roberts (QUT)
Fred Roosta (UQ)
Gabriele Tartaglino Mazzucchelli (UQ)
Valentina Wheeler (Wollongong)
Kazutoshi Yamazaki (UQ)

Local Organising Committee

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Kazutoshi Yamazaki – Treasurer
Timothy Buttsworth – Secretary
Andree McFarlane – Administration
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Ava Greenwood
Joseph Grotowski
Xin Guo
Poh Hillock
Michael Jennings
Masoud Kamgarpour
Ramiro Lafuente
Sharon Lee
Hien Nguyen
Dietmar Oelz

Thanks to John Banks for his assistance with the registration system and the conference booklet, and to the members of the B. H. Neumann Prize Committee, chaired by Tim Garoni, for choosing the best student talks.

Conference Sponsors

Special thanks to Enrico Valdinoci and George Wills (WIMSIG dinner sponsorship).

Conference Program

Overview of the Academic Program

There are 335 talks, among which 13 are plenary lectures and 114 are by students. There are a total of 20 special sessions. The Education Afternoon is scheduled for Wednesday, 6 December 2023.

▷ Conference Timetable – page 8

Tue 5 December – page 44
Wed 6 December – page 52
Thu 7 December – page 59
Fri 8 December – page 64

Plenary Lecturers

►Prof Stephen Wright (University of Wisconsin-Madison)
►Dr Sarah Peluse (University of Michigan)
►Assoc Prof David Ridout (The University of Melbourne)
►Dr Poh Hillock (The University of Queensland)
►Prof Eleonora Di Nezza (Sorbonne Université)
►Prof Takashi Kumagai (Waseda University)
►Prof Guofang Wei (University of California, Santa Barbara)
►Prof Colva Roney-Dougal (University of St Andrews)
►Prof Camillo De Lellis (Institute for Advanced Study)
►Dr Marcy Robertson (The University of Melbourne)
►Prof Peter Bartlett (UC Berkeley)
►Prof Jason Sharples (University of New South Wales)
►Prof Holger Dullin (The University of Sydney)

▷ Timetable of Plenary Lectures – page 8

Special Sessions

Education Afternoon

Organised by Poh Wah Hillock and Michael Jennings. The Education Afternoon is a long-standing tradition at the Society's annual meeting. It brings together high-school maths teachers and academics for an afternoon of practical and thought-provoking discussions in maths education.

- Wednesday, 6 December, 1:30-5pm
  Education Afternoon
  Venue: 69-401

Time	Duration	Activity
1:30 pm – 2:15 pm	45 min	Panel discussion on the secondary-tertiary transition
2:15 pm – 3:15 pm	1 hour	Statistics workshop on "Problem Solving and Modelling Tasks with The Islands" by Dr Michael Bulmer, The University of Queensland
3:30 pm – 4:00 pm	30 min	Afternoon tea
4:00 pm – 5:00 pm	1 hour	Workshop on "Action Research" by Professor Merrilyn Goos, University of the Sunshine Coast

Events

WIMSIG Dinner *Monday, 4 December*, from 6:30pm at Customs House, 399 Queen Street, Brisbane. The venue has advised that the air-conditioning at Customs House does not suit everyone and some guests may find it more comfortable to bring a jacket.
Opening ceremony and prizes *Tuesday, 5 December*, 9am.
LGBTQIA+ and Allies Lunch *Wednesday, 6 December*, lunchtime, in 67-240 (Science Learning Centre).
Conference Dinner *Thursday, 7 December*, from 6pm at Hillstone, Carawa Street, St Lucia, Brisbane. **Buses will be provided for free for all conference registrants, caravanning roundtrip from UQ (Chancellor's place) to the restaurant between 5:30 pm and 6:45 pm, as welll as from UQ to the city center after the dinner.**

Women in Mathematics Special Interest Group (WIMSIG) Business Meeting

- Monday, 4 December, 4-5pm
  WIMSIG Business Meeting
  Venue: UQ St Lucia, Building 61A – Brian Wilson Chancellery, Senate Room or via Zoom (https://unimelb.zoom.us/j/88131311807?pwd=cHFCZ2ZyTHBrZ1lEMFVMc01SYVZRUT09, Password: 847569)

AustMS Student Meeting

- Wednesday, 6 December, 6:30-7:30pm
  AustMS Student Meeting
  Venue: Abel Smith (23-101)

Annual General Meeting of the Society

- Thursday, 7 December, 5pm
  Annual General Meeting of the Society
  Venue: Abel Smith (23-101) or via Zoom https://latrobe.zoom.us/j/81534824431

Conference Information Desk

The information desk for the conference is located in the foyer level 3 of the Advanced Engineering Building (AEB) on Tuesday from 8am to 9am for registration check-in. On Wednesday through Friday, the information desk will be located in the foyer of Abel Smith and staffed from 8:30am to 9am.

Sponsor Presentations

Tuesday, 5 December, lunchtime
Session Title: The Data Evolution: Careers Through Time
Speaker: Dr Virginia Wheway, Head of Data Strategy, Optiver
Session Blurb: Since graduating as a statistician in the early 1990s, Dr Virginia Wheway has seen a lot change in the world of data careers. From statistics to data mining and now data science, data skills have grown in demand - now more than ever. Virginia will share her 30+ years' experience working as a data professional in industries such as aviation, mining, medicine, e-commerce , government and

finance. She will share insights into the skills that employers are looking for in graduates and how her fundamental training in statistics and mathematics, from over three decades ago, is still highly relevant and sought-after today.
Thursday, 7 December, lunchtime

Session Title: Insight into Optiver: Where Maths Can Take You in Industry
Session Blurb: Join this interactive Q&A session hosted by conference partners, Optiver, and hear how intellectual problem solvers and curious minds come together and interact with the dynamic world of trading. From mathematicians to statisticians, developers and researchers, see how the world of mathematics is applied in industry on a daily basis.

Summary timetable

List of Registrants

Current as of Mon 4 Dec 2023

Mr Anjum Mustafa Khan Abbasi (S)	University of New South Wales
Dr Mahdi Abolghasemi (S)	The University of Queensland
Dr Mahdi Abolghasemi	The University of Queensland
Dr Vyacheslav Abramov	N/A
Mr Remy Adderton (S)	The Australian National University
Prof Samir Adly	University of Limoges
Mr Muhammad Afifurrahman (S)	UNSW Sydney
Ms Amal Al Dowais (S)	The University of Western Australia
Mr Seamus Albion (S)	University of Vienna
Prof Amie Albrecht	University of South Australia
Mr Angus Alexander (S)	University of Wollongong
Mr Rashid Ali (S)	university of engineering and technology peshawar
Dr Saleh Almuthaybiri	Qassim University
Mr Lukas Anagnostou (S)	The University of Melbourne
Mr Md Nurul Anwar (S)	The University of Melbourne
Dr Robyn Patrice Araujo	Queensland University of Technology
Miss Nugteren Arwen (S)	None
Dr Jason Atnip	The University of Queensland
Mr Christian Bagshaw (S)	University of New South Wales
Mx Ell Baldwin	None
Prof Rowena Ball	The Australian National University
Dr Agnese Barbensi	The University of Queensland
Mr Jasper Barr (S)	Edith Cowan University
Prof Peter Bartlett	UC Berkeley
Dr Loretta Bartolini	American Mathematical Society
Mr Samuel Barton (S)	The University of Queensland
Mr Benedict Bawagan (S)	None
Dr Nick Beeton	CSIRO
Ms Chiara Bellotti (S)	UNSW Canberra
Mr Lachlan Bennett (S)	The University of Queensland
Dr Luke Bennetts	The University of Adelaide
Prof Jon Berrick	The University of Sydney
Dr Yossi Bokor Bleile (S)	Aalborg University
Dr Rena Bokosmaty	The University of Sydney
Dr James Borger	Australian National University
Ms Olivia Borghi (S)	The University of Melbourne
Prof Kostya Borovkov	The University of Melbourne
Assoc Prof Murk Bottema	Flinders University
Dr Jean-Emile Bourgine	The University of Melbourne
Dr Kyle Broder	The University of Queensland
Mr Steven Buchanan (S)	None
Dr Anh Bui	Macquarie University
Dr Thi Hoa Bui	Curtin University
Mr Yudhistira Andersen Bunjamin (S)	UNSW Sydney
Prof Regina S. Burachik	University of South Australia
Mr Rhuaidi Burke (S)	The University of Queensland
Prof Kevin Burrage	None
Prof Benjamin Burton	The University of Queensland
Dr Timothy Buttsworth	The University of Queensland
Dr Meagan Carney	The University of Queensland
Mr Sergio Carrasco	Universidad de Concepcion
Mr Joshua Celeste (S)	The University of Adelaide
Dr Daniele Celoria	The University of Melbourne
Dr Vivien Challis	Queensland University of Technology
Prof Stephan Chalup	The University of Newcastle

Mr Cameron Chandler	Optiver
Dr Ting-Ying Chang	The University of Sydney
Dr Sunil Chebolu	Illinois State University
Mr Chang Chen (S)	The University of Queensland
Mr Ming Chen (S)	The University of Queensland
Miss Yuhui Chen (S)	Australian National University
Dr Yuyu Chen	The University of Melbourne
Miss Zijun Chen (S)	Monash University
Miss Marrium Chughtai (S)	UNSW Canberra
Mr Andrew Chuter	The University of Sydney
Assoc Prof Florica Corina Cirstea	The University of Sydney
Mr Alexander Clark (S)	The University of Melbourne
Dr Andrea Collevecchio	Monash University
Mr Andrew Cook (S)	Monash University
Mr Luke Cornwell	None
Dr Kevin Coulembier	The University of Sydney
Mr Xavier Coulter (S)	University of Auckland
Assoc Prof Diarmuid Crowley	The University of Melbourne
Dr Tiangang Cui	The University of Sydney
Prof Xianzhe Dai	University of California, Santa Barbara
Dr Michael Dallaston	Queensland University of Technology
Dr Duy-Minh Dang	The University of Queensland
Miss Eden Danielsen-Jensen (S)	University of the Sunshine Coast
Dr Minh N. Dao	RMIT University
Dr Kaustav Das	Monash University
Mr Farrell David (S)	UNSW Sydney
Dr Sara Davies	The University of Queensland
Dr Dougal Davis	The University of Melbourne
Prof Jan De Gier	The University of Melbourne
Prof Camillo De Lellis	Institute for Advanced Study
Dr Alysha De Livera	La Trobe University
Dr Ajani De Vas Gunasekara (S)	Monash University
Mr Bill Deng (S)	UNSW Sydney
Dr Harini Desiraju	The University of Sydney
Prof Eleonora Di Nezza	Sorbonne Université
Mr Nicola Di Vittorio (S)	Macquarie University
Dr Leo Diaz	The University of Melbourne
Dr Reinier Diaz Millan	Deakin University
Mr Yining Ding (S)	The University of Sydney
Prof Serena Dipierro	The University of Western Australia
Ms Ngoc Bao Tran Do	Optiver
Dr Illia Donhauzer	La Trobe University
Prof Diane Donovan	The University of Queensland
Dr Marisa dos Reis Cantarino	Monash University
Dr Mareike Dressler	UNSW Sydney
Prof Yihong Du	University of New England
Mr Adrian Dudek	The University of Queensland
Dr Christopher Duffy	The University of Melbourne
Dr Holger Dullin	The University of Sydney
Dr Huyen Duong	University of New South Wales
Prof Xuan Duong	Macquarie University
Dr Kenneth Duru	The Australian National University
Prof Michael Eastwood	The University of Adelaide
Prof Andrew Craig Eberhard	RMIT University
Prof Murray Elder	University of Technology Sydney
Mr Alistair Falconer (S)	The University of Queensland
Dr Jie Yen Fan	Monash University
Dr Justine Fasquel	The University of Melbourne
Dr Renjie Feng	The University of Sydney

Dr Zhewen Feng	The University of Queensland
Dr Kevin Fergusson	Bond University
Dr Michal Ferov	The University of Newcastle
Prof Lilia Ferrario	Australian National University
Dr Nicholas Fewster-Young	University of South Australia
Dr Laurence Field	Australian National University
Dr Paul Fijn	The University of Melbourne
Assoc Prof Alexander Fish (S)	The University of Sydney
Prof Jennifer Flegg	The University of Melbourne
Dr Mark Flegg	Monash University
Mr Marcus Flook (S)	Australian National University
Mr Matthias Fresacher (S)	Western Sydney University
Prof Gary Froyland	University of New South Wales
Dr Soichiro Fujii	Macquarie University
Mr Peter Gallagher	John Paul College
Ms Grace Garden (S)	The University of Sydney
Dr Sean Gardiner	UNSW Sydney
Assoc Prof Timothy Garoni	Monash University
Dr Sean Gasiorek	California Polytechnic State University
Prof Gabriel Gatica	Universidad de Concepcion
Miss Mashniah Gazwani (S)	The University of Newcastle
Miss Mashniah A. Gazwani (S)	The University of Newcastle
Dr Jesse Gell-Redman	None
Dr Xi Geng	The University of Melbourne
Ms Afsane Ghafari Baghestani	Monash University
Mr Stefano Giannini (S)	The University of Queensland
Mr Matthew Giegerl (S)	The University of Queensland
Prof Miguel Goberna	University of Alicante
Dr Emeka Godwin (S)	Griffith University
Mr Gregory Gold (S)	The University of Queensland
Prof Beniamin Goldys	The University of Sydney
Assoc Prof Cecilia Gonzalez-Tokman	The University of Queensland
Dr Gerardo González Robert	La Trobe University
Dr Jesse Goodman	University of Auckland
Mr Roman Gorazd (S)	The University of Newcastle
Prof Rod Gover	University of Auckland
Mr Joshua Graham (S)	University of New South Wales
Mr Patrick Grant (S)	Queensland University of Technology
Dr Edward Green	The University of Adelaide
Dr Ava Greenwood	The University of Queensland
Prof Joseph Grotowski	The University of Queensland
Dr Hailong Guo	The University of Melbourne
Dr Ivan Guo	Monash University
Ms Jia Min Guo	Optiver
Dr Xin Guo	The University of Queensland
Assoc Prof Zihua Guo	Monash University
Dr Lucas Hackl	None
Dr Joanne Hall	Royal Melbourne Institute of Technology
Dr Lucy Ham	The University of Melbourne
Dr Andy Hammerlindl	Monash University
Mr Jayden Hammet (S)	The University of Melbourne
Prof Kais Hamza	Monash University
Miss Bolin Han (S)	Australian National University
Mr Jeremy Harris	None
Mr Mitchell Harris (S)	The University of Queensland
Assoc Prof Simon Harris	University of Auckland
Assoc Prof David Harvey	University of New South Wales
Dr Daniel Hauer	The University of Sydney
Prof Erika Hausenblas	Montanuniversitaet Leoben

Mx Eli Hazel (S)	Macquarie University
Mr Alexander He (S)	The University of Queensland
Mr Dangyang He (S)	Macquarie University
Mr Kerry He (S)	Monash University
Dr Pedram Hekmati	The University of Auckland
Dr Thomas Hempfling	Springer Nature
Dr Eric William Hester	University of California Los Angeles
Mr Justin Kin Jun Hew (S)	Australian National University
Dr Poh Hillock	The University of Queensland
Prof Pak Tung Ho	Tamkang University
Mr William Hobkirk (S)	The University of Sydney
Dr Liam Hodgkinson	The University of Melbourne
Dr Jeffrey Hogan	The University of Newcastle
Ms Tamara Hogan (S)	The University of Melbourne
Dr Matthew Holden	The University of Queensland
Mr Joshua Holroyd (S)	The University of Sydney
Mr Chris Hone (S)	The University of Sydney
Assoc Prof Min-Chun Hong	The University of Queensland
Assoc Prof Min-Chun Hong	The University of Queensland
Mr Keisuke Hoshino (S)	Kyoto University
Mr Grady Howard (S)	None
Dr Joshua Howie	Monash University
Dr Bingyang Hu	None
Ms Yingkun (Queenie) Huang (S)	University of New South Wales
Mr Stepan Hudecek (S)	The University of Queensland
Ms Connie On Yu HUI (S)	Monash University
Dr Mumtaz Hussain	La Trobe University
Mr Cristian Inzunza (S)	Universidad de Concepcion
Dr Phillip Isaac	The University of Queensland
Dr Deborah Jackson	La Trobe University
Prof Marcel Jackson	La Trobe University
Ms Sakshi Jain	None
Dr Konstantin Jakob	TU Darmstadt
Dr Michael Jennings	The University of Queensland
Assoc Prof Haejun Jeon	Tokyo University of Science
Dr Sam Jeralds	The University of Queensland
Mr Meng Ji (S)	University of Wollongong
Dr Chunxi Jiao	RWTH Aachen University
Mr SHIJIA JIN (S)	Monash University
Mr Stewart John (S)	The University of Melbourne
Mr Mitchell Jones (S)	The University of Queensland
Prof Nalini Joshi	The University of Sydney
Assoc Prof Masoud Kamgarpour	The University of Queensland
Miss Ruethaichanok Kardkasem (S)	The University of Queensland
Dr Sam Kault	The University of Queensland
Assoc Prof Yalcin Kaya	University of South Australia
Mr Thomas Keegan	MATRIX
Dr Andrew Kels	UNSW Sydney
Miss Tara Kemp (S)	The University of Queensland
Mr Alex Kenna (S)	None
Mr Christian Kennedy (S)	The University of Queensland
Dr Kenneth Kenneth Duru	The Australian National University
Dr carolyn kennett	None
Dr Bryce Kerr	UNSW Canberra
Mr Muhammad Awais Khan (S)	Monash University
Mr Saurish Khandelwal (S)	The University of Queensland
Mrs Mst Shanta Khatun (S)	The University of Sydney
Dr Rekha Mallappa Khot	Monash University
Dr Maria Kleshnina	None

Dr Johanna Knapp	The University of Melbourne
Mr MUSASHI KOYAMA (S)	Australian National University
Mr Matthew Kratzer (S)	The University of Queensland
Mr Benjamin Kruger (S)	The University of Queensland
Dr Brian Krummel	The University of Melbourne
Mr Pavel Krupskiy	The University of Melbourne
Prof Takashi Kumagai	Waseda University
Dr Kwok-Kun Kwong	University of Wollongong
Ms Madeleine Kyng (S)	None
Dr Ramiro Augusto Lafuente	The University of Queensland
Dr Bishnu Lamichhane	The University of Newcastle
Dr Mat Langford	None
Mr James Larsen-Scott (S)	Monash University
Prof Finnur Larusson	The University of Adelaide
Ms Sarah Lawson	None
Ms Sarah Lawson	The University of Queensland
Dr Ian Le	Australian National University
Dr Ngan Le	Monash University
Dr Thomas Le Fils	The University of Sydney
Dr Quoc Thong Le Gia	University of New South Wales
Mr Alex Che Yeung Lee (S)	Swinburne University of Technology
Prof Sanghyuk Lee	Seoul National University
Dr James Lefevre	The University of Queensland
Mr Yeming Lei (S)	The University of Queensland
Dr Jean-Simon Lemay	Macquarie University
Mr Nicol Leong (S)	UNSW Canberra
Dr Paul Charles Leopardi	Australian National University
Mr Renaud Leplaideur	Université de la Nouvelle Calédonie
Mr Pui Kuen Leung (S)	Australian National University
Dr Haibo Li	The University of Melbourne
Dr Ji Li	Macquarie University
Dr Libo Li	University of New South Wales
Mr Oliver Li (S)	AMSI/University of Melbourne
Mrs Wanping Li (S)	None
Mr Wei Li (S)	Monash University
Mr Xian Li (S)	None
Dr Yau Wing Li	The University of Melbourne
Dr Scott Boivin Lindstrom	Curtin University
Assoc Prof Jon Links	The University of Queensland
Ms Michelle Lirakusuma (S)	None
Ms Eloise Little (S)	The University of Sydney
Dr Jiakun Liu	University of Wollongong
Dr Qingwei Liu	Nanyang Technological University
Dr Ruyi Liu	The University of Sydney
Mr Yijia Liu (S)	Australian National University
Prof John Loxton	Macquarie University
Ms Jimeng Lu (S)	None
Dr Yaowen Lu	None
Dr Inna Lukyanenko	The University of Queensland
Dr Fu Ken Ly	The University of Sydney
Dr Sean Lynch	UNSW Sydney
Mr kai machida (S)	AMSI/University of Melbourne
Mr Jason Mackellar (S)	The University of Newcastle
Mr Christian Degnbol Madsen (S)	The University of Melbourne
Assoc Prof Barbara Maenhaut	The University of Queensland
Prof Ross Maller	Australian National University
Mr Connor Mallon (S)	Monash University
Dr Diana Mandar	Griffith University
Mr Vishnu Mangalath (S)	Australian National University

Mr Lex Anton Marano (S)	None
Dr Greg Markowsky	Monash University
Dr Ian Marquette	The University of Queensland
Dr Bree Martin	The University of Queensland
Assoc Prof Daniel Mathews	Monash University
Mr Brendan Matthews (S)	None
Mx Natalia McAlister Caffarel (S)	Monash University
Dr Nick McConnell	Defence Science and Technology Group
Prof James McCoy	The University of Newcastle
Prof Timothy McDevitt	Elizabethtown College
Dr Lachlan McKinna	GO2Q
Prof Geoffrey McLachlan	The University of Queensland
Dr Peter McNamara	The University of Melbourne
Mr William Mead (S)	The University of Melbourne
Miss Morgan Meertens (S)	The University of Auckland
Mr Joseph Menesch (S)	The University of Queensland
Miss Jahne Meyer (S)	The University of Newcastle
Dr Javier Milei	None
Prof Dragan Milicic	None
Dr Sarat Babu Moka	UNSW Sydney
Mr James Morgan (S)	The University of Sydney
Dr Kerri Morgan	Royal Melbourne Institute of Technology
Prof Sidney Morris (S)	None
Miss Ellena Moskovsky (S)	Optiver
Dr Stephen Muirhead	The University of Melbourne
Dr Debopriya Mukherjee	Indian Institute of Technology Indore
Assoc Prof Tomonori Nakatsu	Shibaura Institute of Technology
Dr Kihun Nam	Monash University
Dr Ashvni Narayanan	The University of Sydney
Mr Yerlan Nessipbayev (S)	University of New South Wales
Mr Jack William Neubecker (S)	The University of Queensland
Mr Joseph Newton (S)	The University of Sydney
Mr Joseph Newton (S)	The University of Sydney
Mr Brandon Nguyen	Optiver
Dr Hieu Thao Nguyen	RMIT University Vietnam
Mrs Lien Nguyen (S)	RMIT University
Dr Benitho Amaobi Ngwu	Federal University Oye Ekiti
Miss Clarinda Nhangumbe (S)	University of Cape Town
Mr Dion Nikolic (S)	UNSW Canberra
Prof Paul Norbury	The University of Melbourne
Dr Graham Norton	The University of Queensland
Ms Madeline Nurcombe (S)	The University of Queensland
Dr Dietmar Oelz	The University of Queensland
Dr Peter Olamide Olanipekun	The University of Auckland
Miss Renee Oldfield (S)	The University of Queensland
Assoc Prof Andriy Olenko	La Trobe University
Mr Max Orchard (S)	The University of Queensland
Mr Ibrahim Orhan (S)	RMIT University
Dr Marcos Orseli (S)	The University of Adelaide
Mr Jack Palmer (S)	University of New England
Dr Akash Ashirbad Panda	Indian Institute of Technology Bhubaneswar
Dr Azeef Muhammed Parayil Ajmal	University of Western Sydney
Mr Anthony Parr (S)	The University of Queensland
Dr Bregje Pauwels	Macquarie University
Dr Vinesha Peiris	Curtin University
Dr Sarah Peluse	University of Michigan
Mr Fei Peng (S)	The University of Melbourne
Mr Aram Perez (S)	Monash University
Mr Joshua Peters (S)	None

Dr Ravindra Pethiyagoda	The University of Newcastle
Mr Tan Pham (S)	Federation University Australia
Dr Adam Piggott	Australian National University
Dr Guillermo Pineda-Villavicencio	Deakin University
Mx João Vitor Pinto e Silva (S)	The University of Newcastle
Mr David Plenty (S)	University of Wollongong
Dr Giorgio Poggesi	The University of Western Australia
Dr Juan Carlos Ponce Campuzano	The University of Queensland
Mr Chris Powell	None
Dr John Power	Macquarie University
Prof Geoff Prince	La Trobe University
Dr Abraham Love Prins	Nelson Mandela University
Mr Robert Pryor (S)	The University of Melbourne
Assoc Prof Artem Pulemotov	The University of Queensland
Prof Jessica Purcell	Monash University
Mr Tao Qin (S)	The University of Sydney
Mrs Thakshila Rajapaksha (S)	University of Wollongong
Mr Damodar Rajbhandari (S)	The University of Melbourne
Prof Jorgen Rasmussen	The University of Queensland
Ms Caren Rattray	None
Dr Lawrence Reeves	The University of Melbourne
Dr Colin David Reid	The University of Newcastle
Dr Marcia Ricci Pinheiro	None
Assoc Prof David Ridout	The University of Melbourne
Dr Janosch Rieger	Monash University
Prof John Roberts	University of New South Wales
Prof Tony Roberts	Queensland University of Technology
Dr Marcy Robertson	The University of Melbourne
Prof Sergio Rojas	Pontificia Universidad Católica de Valparaíso
Dr Anna Romanov	UNSW Sydney
Prof Colva Roney-Dougal	University of St Andrews
Mr Fred Roosta	The University of Queensland
Mrs Efat Rostami Khosroabadi (S)	Queensland University of Technology
Mr Andres Eduardo Rubiano Martinez (S)	Monash University
Dr Mufutau Ajani Rufai (S)	Free University of Bozen-Bolzano
Assoc Prof Ricardo Ruiz Baier	Monash University
Mr Jackson Ryder (S)	UNSW Sydney
Assoc Prof Leanne Rylands	Western Sydney University
Mr Xiao Sa (S)	The University of Sydney
Dr Thomas Scheckter	UNSW Sydney
Miss Aisha Schreiber (S)	None
Dr Travis Scrimshaw	Hokkaido University
Miss Narges Shabgard (S)	University of New England
Dr Nazish Shahid	Forman Christian College (A Chartered University) Lahore, Pakistan
Prof Jason Sharples	University of New South Wales
Mr Jordan Shaw-Carmody (S)	The University of Newcastle
Dr Alexander Sherman	The University of Sydney
Prof Lei Shi	Fudan University
Dr Nikita Shulga (S)	La Trobe University
Prof Harvinder Sidhu	University of New South Wales
Dr Leesa Sidhu	University of New South Wales Canberra
Dr Adam Sikora	Macquarie University
Dr Aleksander Simonic	University of New South Wales Canberra
Dr Leonie Simpson	Queensland University of Technology
Prof Aidan Sims	University of Wollongong
Mr Chandan Singh (S)	The University of Melbourne
Dr Niharika Singh	University of Southern Queensland
Dr Matthew Paul Skerritt	RMIT University

Mr Oscar Smee (S)	The University of Queensland
Dr Liam Smith (S)	The University of Queensland
Miss Rebecca Smith (S)	The University of Newcastle
Dr anthony sofo	None
Miss Ksenia Sofronova (S)	UNSW Sydney
Dr Leah South	Queensland University of Technology
Mr James Stanfield (S)	The University of Queensland
Ms Valeriia Starichkova (S)	UNSW Canberra
Prof Yury Stepanyants	University of Southern Queensland
Mr Kurt Stoeckl (S)	The University of Melbourne
Mr Artem Stoian (S)	The University of Melbourne
Prof Yvonne Stokes	The University of Adelaide
Dr Michelle Strumila	Monash University
Mr Lecheng Su (S)	Monash University
Dr Nadia Sukhorukova	Swinburne University of Technology
Prof Thangavelu Sundaram	Indian Institute of Science Bangalore
Ms Cassady Swinbourne (S)	The University of Queensland
Dr Thomas Taimre	The University of Queensland
Dr Matthew Tam	The University of Melbourne
Dr Gabriele Tartaglino Mazzucchelli	The University of Queensland
Prof Peter Gerrard Taylor	The University of Melbourne
Mr Adam Thompson (S)	The University of Queensland
Dr Bevan Thompson	The University of Queensland
Mx Em Thompson (S)	Monash University
Miss Finn Thompson (S)	The University of Queensland
Mr Jack Thompson (S)	The University of Western Australia
Dr Aaron Thornton	CSIRO
Prof Stephan Tillmann	The University of Sydney
Assoc Prof Gould Tim	Griffith University
Mr Liam Timms (S)	The University of Melbourne
Prof Chris Tisdell	University of New South Wales
Ms Lucy Tobin (S)	The University of Sydney
Dr Kane Townsend	University of Technology Sydney
Mr Andy Tran (S)	The University of Sydney
Dr TriThang Tran	The University of Melbourne
Mr Aholiab Tritama (S)	Deakin University
Prof Timothy Trudgian	UNSW Canberra
Mrs May Truong	None
Prof Warwick Tucker	Monash University
Prof Ian Turner	QUT
Dr Jai Tushar	Monash University
Mr ABHILASH TUSHIR (S)	None
Prof Abdullahi Umar	Khalifa University of Science, Technology
Mr Daniel Uteda (S)	The University of Melbourne
Prof Enrico Valdinoci	The University of Western Australia
Mr Jaco van Tonder (S)	The University of Queensland
Dr Geetika Verma	RMIT University
Dr Segundo Villa Fuentes	Monash University
Dr Mircea Voineagu	University of New South Wales
Dr Raymond Vozzo	The University of Adelaide
Dr Thao Thuan Vu Ho	Monash University
Mr Liang Wang (S)	The University of Queensland
Dr Rong Wang	The Australian National University
Ms Shuyi Wang	Optiver
Mr Ziyang Wang (S)	The University of Queensland
Mr Ziyi Wang (S)	None
Dr Benjamin Ward	La Trobe University
Prof Ole Warnaar	The University of Queensland
Dr David James Warne	Queensland University of Technology

Dr Simon Watt	UNSW Canberra
Ms Georgia Weatherley (S)	Queensland University of Technology
Prof Martin Wechselberger	The University of Sydney
Mrs Weerasinghe Mohottige Hasitha Nilakshi Weerasinghe	Queensland University of Technology
Mr Zachary James Wegert (S)	Queensland University of Technology
Prof Guofang Wei	University of California, Santa Barbara
Dr Jason Werry	The University of Queensland
Mr Oliver West (S)	The University of Queensland
Dr Glen Edward Wheeler	University of Wollongong
Dr Virginia Wheway	Optiver
Mr Bailey Whitbread (S)	The University of Queensland
Dr Jörn Wichmann	Monash University
Mr Scott Wiggins (S)	University of Southern Queensland
Mr Dilshan Wijesena (S)	University of New South Wales
Miss Eve Wilkes (S)	None
Prof Geordie Williamson	None
Prof George Willis	The University of Newcastle
Ms Sinead Wilson (S)	The Australian National University
Mr Jonathan Wilton (S)	The University of Queensland
Mr Hosea Wondo (S)	The University of Sydney
Dr Stephen Wright	University of Wisconsin-Madison
Dr binghao wu (S)	None
Ms Vicky Wu	Optiver
Mr Victor Wu (S)	The University of Sydney
Prof Aihua Xia	The University of Melbourne
Dr Binzhou Xia	The University of Melbourne
Prof Hong-Kun Xu	Hangzhou Dianzi University
Miss Huansang Xu (S)	The University of Sydney
Mr Yunxi Xu (S)	Monash University
Dr Kazutoshi Yamazaki	The University of Queensland
Mr Andrew Yang (S)	UNSW Canberra
Dr Nan Ye	None
Dr David Yost	Federation University Australia
Ms Lihexuan Yuan (S)	The University of Melbourne
Miss Yongjia Yuan (S)	Federation University Australia
Mr Wenqi Yue (S)	The University of Sydney
Ms Adriana Zanca	The University of Melbourne
Mr Zehua Zang (S)	The University of Auckland
Mr Zeaiter Zeaiter (S)	The University of Sydney
Mr Chuanqi Zhang (S)	University of Technology Sydney
Dr Erchuan Zhang	Edith Cowan University
Mr Rui Zhang (S)	Monash University
Miss Xinyue Zhang (S)	Australian National University
Dr Yang Zhang	The University of Queensland
Mr Yile Zhang (S)	None
Mr Zhaorui Zhang (S)	The University of Queensland
Mr Hongyin Zhao (S)	University of New South Wales
Mr Hao Zhou (S)	The University of Queensland
Dr yang zhou	University of Wollongong
Ms Yuyang Zhou (S)	None
Dr Zhou Zhou	The University of Sydney
Dr Zongzheng Zhou	Monash University
Dr Jieru Zhu	None
Ms Ruixuan Zhu (S)	Australian National University
Prof Paul Zinn-Justin	The University of Melbourne
Mr Orion Zymaris (S)	Monash University
Mr Gavrilo Šipka (S)	The University of Queensland

Sessions

Plenary Lectures in 49-200 (Tue) and 23-101 (Wed–Fri)

▷ Tue 5 December

11:30 Sarah Peluse (University of Michigan)
Arithmetic patterns in dense sets
49-200 (p. 71)

17:30 Camillo De Lellis (Institute for Advanced Study)
Area-minimizing integral currents: singularities and structure
49-200 (p. 70)

▷ Wed 6 December

09:00 Holger Dullin (The University of Sydney)
On the Stability of the 3-Body Problem
Abel Smith (p. 70)

10:30 Colva Roney-Dougal (University of St Andrews)
Counting groups
Abel Smith (p. 72)

11:30 Peter Bartlett (UC Berkeley)
Benign Overfitting
Abel Smith (p. 70)

17:30 Poh Hillock (The University of Queensland)
Transforming First Year Mathematics: opening doors to success
Abel Smith (p. 71)

▷ Thu 7 December

09:00 Eleonora Di Nezza (Sorbonne Université)
Ricci-flat spaces: one of the building-blocks of the Universe
Abel Smith (p. 70)

10:30 David Ridout (The University of Melbourne)
In which Physics demands new Mathematics
Abel Smith (p. 71)

11:30 Takashi Kumagai (Waseda University)
Anomalous random walks and scaling limits: from fractals to random media
Abel Smith (p. 71)

16:00 Jason Sharples (University of New South Wales)
Modelling dynamic fire propagation and extreme bushfire development
Abel Smith (p. 72)

▷ Fri 8 December

09:00 Marcy Robertson (The University of Melbourne)
Proped up homotopy theory
Abel Smith (p. 72)

10:30 Guofang Wei (University of California, Santa Barbara)
Fundamental Gap of Convex Domains in Space Forms and Surfaces
Abel Smith (p. 72)

11:30 Stephen Wright (University of Wisconsin-Madison)

Optimization in Theory and Practice
Abel Smith (p. 73)

Session 2: Applied and Industrial Mathematics

Organiser: Simon Watt

Contributed Talks

▷ Tue 5 December

13:30 Matthew Holden (The University of Queensland)
Quantifying the value of data and models for environmental management
14-115 (p. 74)

14:00 Liam Timms (The University of Melbourne)
Saving elephants with rangers and real estate: optimizing conservation funding
14-115 (p. 77)

14:30 Thomas Taimre (The University of Queensland)
Rare-event simulation techniques for structured fisheries models
14-115 (p. 77)

15:00 Aaron Thornton (CSIRO)
Modelling Intrinsically Disordered Proteins using Mechanical Hoberman Spheres
14-115 (p. 77)

16:00 Mark Flegg (Monash University)
Modelling of a Tomato Glasshouse
14-115 (p. 74)

16:30 Ruethaichanok Kardkasem (The University of Queensland)
Extreme Precipitation on the Eastern Coast of Australia
14-115 (p. 75)

17:00 Jason Mackellar (The University of Newcastle)
Towards an algorithm for the de-convolution of fractionation data
14-115 (p. 75)

▷ Wed 6 December

13:30 Adriana Zanca (The University of Melbourne)
Cell differentiation architectures
14-115 (p. 78)

14:00 James Lefevre (The University of Queensland)
Optimal control of Multiple Myeloma assuming drug evasion and off-target effects
14-115 (p. 75)

14:30 Benitho Amaobi Ngwu (Federal University Oye Ekiti)
Geometric Singular Perturbation Approach to GlassŃetworks
14-115 (p. 76)

15:00 Lucy Ham (The University of Melbourne)
Deterministic hares, and stochastic tortoises: the timing of cellular events
14-115 (p. 74)

16:30 Yining Ding (The University of Sydney)
Pricing and Hedging of Cross-Currency Basis Swaps Referencing Backward-Looking Rates
14-115 (p. 74)

17:00 Huansang Xu (The University of Sydney)
Equity Protection Swaps: A New Type of Risk Management Products for Pension Funds
14-115 (p. 78)

▷ Thu 7 December

13:30 Yury Stepanyants (University of Southern Queensland)
Lumps and their interactions in the cylindrical Kadomtsev–Petviashvili equation
14-115 (p. 76)

14:00 Murk Bottema (Flinders University)
Integrals of sinc function shifted by integer multiples of pi
14-115 (p. 73)

14:30 Leo Diaz (The University of Melbourne)
Hypergraph representations for systems biology
14-115 (p. 73)

15:00 Luke Bennetts (The University of Adelaide)
Broadband energy capture by an array of heaving buoys
14-115 (p. 73)

▷ Fri 8 December

13:30 Dietmar Oelz (The University of Queensland)
A mechanochemical model for symmetry breaking in Hydra spheroids
14-115 (p. 76)

14:00 Timothy McDevitt (Elizabethtown College)
Impossible Pair Attacks Against Nonlinear Combiners
14-115 (p. 75)

14:30 Simon Watt (UNSW Canberra)
Chaotic flow in competitive exothermic-endothermic reaction systems
14-115 (p. 77)

Session 3: Category Theory, Homotopy Theory, and K-Theory

Organisers: Soichiro Fujii, Marcy Robertson, Mircea Voineagu

Contributed Talks

▷ Tue 5 December

13:30 Fei Peng (The University of Melbourne)
Fourier–Mukai transforms for Deligne–Mumford stacks
03-262 (p. 81)

14:00 Joshua Graham (University of New South Wales)
Equivariant Motivic Cohomology and it's relationship to Bredon Cohomology
03-262 (p. 80)

14:30 Alexander Clark (The University of Melbourne)
Classifying t-structures on filtered tensor-triangulated categories
03-262 (p. 79)

15:00 Bill Deng (UNSW Sydney)
The $RO(G)$-graded cohomology of $E_{\Sigma_2}C_2$
03-262 (p. 79)

16:00 Jayden Hammet (The University of Melbourne)
U_α-bordism: a refinement of complex bordism
03-262 (p. 80)

16:30 Olivia Borghi (The University of Melbourne)
Commutativity in Higher Algebraic Objects
03-262 (p. 78)

17:00 Kurt Stoeckl (The University of Melbourne)
Homotopy Probs and Other G-Operadic Structures.
03-262 (p. 82)

▷ Wed 6 December

13:30 Nicola Di Vittorio (Macquarie University)
Introduction to the theory of 2-derivators
03-262 (p. 79)

14:00 Tamara Hogan (The University of Melbourne)
A knot theoretic interpretation of the Goldman-Turaev Lie bialgebra
03-262 (p. 80)

14:30 Chandan Singh (The University of Melbourne)
ON RELATIVE STRUCTURE OF VIRTUAL TANGLES
03-262 (p. 82)

15:00 Keisuke Hoshino (Kyoto University)
Double categories of relations relative to factorisation systems
03-262 (p. 80)

16:00 Raymond Vozzo (The University of Adelaide)
Rigid 2-gerbes and applications
03-262 (p. 82)

16:30 Diarmuid Crowley (The University of Melbourne)
Stably homeomorphic 4-manifolds
03-262 (p. 79)

▷ Thu 7 December

13:30 Jean-Simon Lemay (Macquarie University)
Hopf Monads on Biproducts
03-262 (p. 81)

14:00 Mircea Voineagu (University of New South Wales)
Bredon motivic cohomology of real numbers
03-262 (p. 82)

14:30 Soichiro Fujii (Macquarie University)
Enrichment preserves fibrations
03-262 (p. 80)

15:00 Michelle Strumila (Monash University)
An overview of infinity modular operads
03-262 (p. 82)

Session 4: Discrete Geometry

Organisers: Guillermo Pineda-Villavicencio, Julien Ugon

Contributed Talks

▷ Wed 6 December

13:30 David Yost (Federation University Australia)
The excess degree of a polytope
01-E212 (p. 83)

14:00 Aholiab Tritama (Deakin University)
Ramsey number on the graphs of dual cyclic polytopes
01-E212 (p. 83)

14:30 Guillermo Pineda-Villavicencio (Deakin University)
Counting and analysing faces of convex polytopes
01-E212 (p. 83)

Session 5: Computational Mathematics

Organisers: Bishnu Lamichhane, Quoc Thong Le Gia, Ricardo Ruiz Baier

Contributed Talks

▷ Tue 5 December

13:30 Connor Mallon (Monash University)
Neural Level Set Topology Optimisation using Unfitted Finite Elements
03-309 (p. 89)

14:00 Andres Eduardo Rubiano Martinez (Monash University)
Virtual element methods for coupled stress-assisted diffusion problems
03-309 (p. 90)

14:30 Zachary James Wegert (Queensland University of Technology)
A Hilbertian projection method for constrained level set-based topology optimisation
03-309 (p. 92)

15:00 Matthew Paul Skerritt (RMIT University)
Computing and Optimising Fisher Information for Partially Observable Simple Birth Processes
03-309 (p. 90)

16:00 Mst Shanta Khatun (The University of Sydney)
Mathematical Modelling of Cancer Evolution
03-309 (p. 86)

16:30 Wei Li (Monash University)
Finite element interpolated neural networks for solving forward and inverse problems
03-309 (p. 88)

17:00 Cristian Inzunza (Universidad de Concepcion)
A Banach spaces-based fully-mixed finite element method for the coupled poroelasticity and Poisson–Nernst–Planck equations
03-309 (p. 86)

▷ Wed 6 December

13:30 Yijia Liu (Australian National University)
Optimal parameter analysis of PML model and application of multi-block strategy in efficient numerical simulation of 2D acoustic waves in unbounded domain
03-309 (p. 88)

14:00 Kenneth Duru (The Australian National University)
On entropy stable and mimetic discontinuous Galerkin finite element methods for the rotating thermal shallow water equations in complex geometries
03-309 (p. 85)

14:30 Tiangang Cui (The University of Sydney)
Scalable conditional transport maps using tensor trains
03-309 (p. 84)

15:00 Lei Shi (Fudan University)
Classification with Deep Neural Networks
03-309 (p. 90)

16:00 Gabriel Gatica (Universidad de Concepcion)
Banach spaces-based mixed finite element methods for the convective Brinkman–Forchheimer problem and its coupling with Darcy equation
03-309 (p. 85)

16:30 Sergio Carrasco (Universidad de Concepcion)
New mixed finite element methods for the coupled convective Brinkman-Forchheimer and double-diffusion equations

03-309 (p. 84)

17:00 Segundo Villa Fuentes (Monash University)
A new fully-mixed formulation for the Navier–Stokes/Darcy equations
03-309 (p. 91)

▷ Thu 7 December

13:30 Jai Tushar (Monash University)
Optimal Control of Stationary Doubly Diffusive Flows on Two and Three Dimensional Bounded Lipschitz Domains: Numerical Analysis
03-309 (p. 91)

14:00 Ian Turner (QUT)
Multiscale modelling of heterogeneous porous media using implicit evolution equations
03-309 (p. 91)

14:30 Haibo Li (The University of Melbourne)
A preconditioned Krylov subspace method for linear inverse problems with general-form Tikhonov regularization
03-309 (p. 88)

15:00 Hailong Guo (The University of Melbourne)
Discontinuous Galerkin methods for the Laplace-Beltrami operator on point cloud
03-309 (p. 85)

▷ Fri 8 December

13:30 Xin Guo (The University of Queensland)
Capacity dependent analysis for functional online learning algorithms
03-309 (p. 86)

14:00 Sergio Rojas (Pontificia Universidad Católica de Valparaíso)
Local minimum-residual a posteriori error estimates for a class of mixed finite element discretizations
03-309 (p. 89)

14:30 Ricardo Ruiz Baier (Monash University)
Twofold saddle-point formulations for stress-altered diffusion models
03-309 (p. 90)

15:00 Bishnu Lamichhane (The University of Newcastle)
A mixed finite element method for fourth and sixth-order partial differential equations
03-309 (p. 87)

16:00 Rekha Mallappa Khot (Monash University)
Conforming virtual element method for forward and inverse source problems with rough data
03-309 (p. 87)

16:30 Ashvni Narayanan (The University of Sydney)
A tool for autoformalization of mathematics in Lean
03-309 (p. 89)

17:00 Quoc Thong Le Gia (University of New South Wales)
Quasi-Monte Carlo sparse grid Galerkin FEMs for linear elasticity equations with uncertainties
03-309 (p. 87)

Session 6: Dynamical Systems and Ergodic Theory

Organisers: Jason Atnip, Gary Froyland, Warwick Tucker

Contributed Talks

▷ Tue 5 December

13:30 Jason Atnip (The University of Queensland)
Universal Gap Growth for Lyapunov Exponents of Perturbed Matrices
35-519 (p. 92)

14:00 Sakshi Jain (None)
Piecewise Contracting Systems
35-519 (p. 93)

14:30 Amal Al Dowais (The University of Western Australia)
Lyapunov exponents for open billiard flows
35-519 (p. 92)

15:00 Joshua Peters (None)
Prevalence of stability for smooth Blaschke product cocycles fixing the origin
35-519 (p. 94)

▷ Wed 6 December

13:30 Natalia McAlister Caffarel (Monash University)
Computer-aided proofs for blenders
35-519 (p. 94)

14:00 Andrew Cook (Monash University)
Nowhere coexpanding functions
35-519 (p. 92)

14:30 Benjamin Ward (La Trobe University)
Irrational rotations in higher dimensions
35-519 (p. 95)

15:00 Marisa dos Reis Cantarino (Monash University)
u-Gibbs measure rigidity for uniformly expanding partially hyperbolic endomorphisms on surfaces
35-519 (p. 93)

▷ Thu 7 December

13:30 Andy Hammerlindl (Monash University)
Partial Hyperbolicity on Seifert manifolds
35-519 (p. 93)

14:00 Gerardo González Robert (La Trobe University)
Dynamical aspects of complex continued fractions
35-519 (p. 93)

14:30 Renaud Leplaideur (Université de la Nouvelle Calédonie)
Selection in ergodic Optimization
35-519 (p. 94)

15:00 Sean Gasiorek (California Polytechnic State University)
Dynamics and Periodicity Conditions for the Integrable Boltzmann System
35-519 (p. 93)

▷ Fri 8 December

13:30 Martin Wechselberger (The University of Sydney)
(Hidden) multiple timescales and the parametrisation method in geometric singular perturbation theory
67-442 (p. 95)

14:00 John Roberts (University of New South Wales)
Rotations of the circle and their symbolic dynamics
67-442 (p. 94)

14:30 Warwick Tucker (Monash University)
The Songling system has exactly four limit cycles
67-442 (p. 95)

Session 7: Equity, Diversity and Inclusion in Mathematics

Organisers: Matthew Holden

Contributed Talks

▷ Wed 6 December

13:30 Liam Timms (The University of Melbourne)
Creating inclusive classrooms in mathematics
67-442 (p. 97)

14:00 Masoud Kamgarpour (The University of Queensland)
Can we communicate maths better?
67-442 (p. 96)

14:30 Nalini Joshi (The University of Sydney)
Vision for Equity, Diversity and Inclusion in the AustMS: past, current and future actions (Part I)
67-442 (p. 96)

15:00 Nalini Joshi (The University of Sydney)
Vision for Equity, Diversity and Inclusion in the AustMS: past, current and future actions (Part II)
67-442 (p. 96)

▷ Thu 7 December

13:30 Marcy Robertson (The University of Melbourne)
What if Sherman Alexie were a mathematician ?
67-442 (p. 97)

14:00 Rowena Ball (The Australian National University)
Equity and diversity OF mathematics
67-442 (p. 95)

14:30 Benjamin Burton (The University of Queensland)
Diversity in academic competitions: Success, failures, and works in progress
67-442 (p. 96)

15:00 Leah South (Queensland University of Technology)
A plan for reducing sexual assault and sexual harassment
67-442 (p. 97)

Session 8: Functional Analysis

Organisers: David Robertson, Thomas Scheckter

Contributed Talks

▷ Tue 5 December

17:00 Jimeng Lu (None)
Pisier's Question: Steinberg Theorem Revisited
35-519 (p. 98)

▷ Wed 6 December

16:00 Farrell David (UNSW Sydney)
An Abstract Approach to Principal Symbol Calculus
35-519 (p. 98)

16:30 Angus Alexander (University of Wollongong)
An index pairing in scattering theory
35-519 (p. 98)

17:00 Hongyin Zhao (University of New South Wales)
Kuroda's theorem for n-tuples in semifinite factors
35-519 (p. 99)

▷ Fri 8 December

15:00 Vyacheslav Abramov (N/A)
Fixed point theorem for an infinite Toeplitz matrix and its extension to general infinite matrices
67-442 (p. 97)

16:00 Aidan Sims (University of Wollongong)
Reconstruction of Lie groupoids from spectral data
67-442 (p. 98)

16:30 Thomas Scheckter (UNSW Sydney)
Noncommutative L^p Spaces are Primary
67-442 (p. 98)

Session 9: Geometric Analysis

Organisers: Mat Langford

Contributed Talks

▷ Tue 5 December

16:00 Kyle Broder (The University of Queensland)
A Locality Theorem for Einstein Metrics on Compact Complex Manifolds
08-212 (p. 99)

16:30 James Stanfield (The University of Queensland)
Pluriclosed Metrics with Negative Holomorphic Sectional Curvature
08-212 (p. 101)

17:00 Adam Thompson (The University of Queensland)
Ricci solitons with non-compact symmetry
08-212 (p. 102)

▷ Wed 6 December

13:30 Jahne Meyer (The University of Newcastle)
Evolving polygons via semi-discrete polyharmonic geometric flows
08-212 (p. 101)

14:00 Mashniah Gazwani (The University of Newcastle)
Curvature diffusion of planar curves with generalised Neumann boundary conditions inside cones
08-212 (p. 99)

14:30 Marcus Flook (Australian National University)
Flows of real hypersurfaces immersed in complex space by Levi curvature
08-212 (p. 99)

15:00 Peter Olamide Olanipekun (The University of Auckland)
A Rigidity Result for Four Dimensional Willmore-type Submanifolds
08-212 (p. 101)

▷ Thu 7 December

13:30 Rod Gover (University of Auckland)
Conformal aspects of submanifolds and curves
08-212 (p. 100)

14:30 James McCoy (The University of Newcastle)
Higher order linear curvature flow
08-212 (p. 101)

15:00 Glen Edward Wheeler (University of Wollongong)
Using an ODE to prove the parametrised isoperimetric inequality
08-212 (p. 102)

▷ Fri 8 December

13:30 Min-Chun Hong (The University of Queensland)
On Chen's conjecture for biharmonic hypersurfaces
08-212 (p. 100)

14:00 Giorgio Poggesi (The University of Western Australia)
Soap bubbles and convex cones
08-212 (p. 101)

14:30 Brian Krummel (The University of Melbourne)
Analysis of singularities of area minimizing currents
08-212 (p. 100)

15:00 Pak Tung Ho (Tamkang University)
Results related to prescribing Gaussian curvature and geodesic curvature
08-212 (p. 100)

Session 10: Algebra and Combinatorics

Organisers: Lawrence Reeves, Binzhou Xia, Sanming Zhou

Contributed Talks

▷ Tue 5 December

13:30 George Willis (The University of Newcastle)
Scale groups
01-E302 (p. 106)

14:00 Adam Piggott (Australian National University)
Quasi-transitive geodetic graphs Part I
01-E302 (p. 105)

14:30 Kane Townsend (University of Technology Sydney)
Quasi-transitive geodetic graphs Part II
01-E302 (p. 106)

15:00 Murray Elder (University of Technology Sydney)
On the complexity of epimorphism testing with virtually abelian targets
01-E302 (p. 103)

16:00 Roman Gorazd (The University of Newcastle)
Higman Thompson groups and Leavitt path algebras of graphs
01-E302 (p. 103)

16:30 Matthias Fresacher (Western Sydney University)
Congruence Lattices of Finite Twisted Brauer Monoids
01-E302 (p. 103)

17:00 Samuel Barton (The University of Queensland)
A new classification model based on a population of hypergraphs
01-E302 (p. 102)

▷ Wed 6 December

13:30 Erchuan Zhang (Edith Cowan University)
Antiregular k-hypergraph and independent polynomial
01-E302 (p. 107)

14:00 Sarah Lawson (The University of Queensland)
Tudisco and Higham's Nonlinear Eigenvector Centrality for Hypergraphs and its application to biological processes
01-E302 (p. 104)

14:30 Barbara Maenhaut (The University of Queensland)
A Family of Connected 1-Factorisations of Complete 3-Uniform Hypergraphs
01-E302 (p. 105)

15:00 Yudhistira Andersen Bunjamin (UNSW Sydney)
Using 4-GDDs to construct 3-GDDs
01-E302 (p. 102)

16:00 Chuanqi Zhang (University of Technology Sydney)
On linear-algebraic notions of expansion
01-E302 (p. 106)

16:30 Afsane Ghafari Baghestani (Monash University)
Construction of Latin squares with restricted transversals
01-E302 (p. 103)

17:00 Tara Kemp (The University of Queensland)
Latin hypercubes realizing integer partitions
01-E302 (p. 104)

▷ Thu 7 December

14:00 Kerri Morgan (Royal Melbourne Institute of Technology)
Certificates of Splitting Field Equivalence for the Chromatic Polynomial
01-E302 (p. 105)

14:30 Marcel Jackson (La Trobe University)
Some finite model theoretic considerations in algebra
01-E302 (p. 104)

15:00 Sunil Chebolu (Illinois State University)
The Resonance Hyperplane Arrangement
01-E302 (p. 103)

▷ Fri 8 December

14:00 Marcia Ricci Pinheiro (None)
Equal Probability for the Monty Hall Problemś Options
01-E302 (p. 106)

14:30 Sean Lynch (UNSW Sydney)
Generating functions in algebra, combinatorics and algebraic geometry
01-E302 (p. 105)

15:00 Paul Charles Leopardi (Australian National University)
Relations between equivalences of bent functions
01-E302 (p. 104)

Session 11: Harmonic Analysis

Organisers: Anh Bui, Zihua Guo, Ji Li

Contributed Talks

▷ Tue 5 December

13:30 Sanghyuk Lee (Seoul National University)
L^p bounds on the strong spherical maximal functions
08-212 (p. 109)

14:00 Ji Li (Macquarie University)
Some recent progress on analysis on model domains
08-212 (p. 109)

14:30 Jeffrey Hogan (The University of Newcastle)
Clifford translations, splines and bandpass bases
08-212 (p. 108)

15:00 Fu Ken Ly (The University of Sydney)
Higher order Riesz transforms and almost diagonality for Hermite expansions
08-212 (p. 109)

▷ Wed 6 December

13:30 Thangavelu Sundaram (Indian Institute of Science Bangalore)
On the range of Poisson transform on noncompact Riemannian symmetric spaces
08-257 (p. 110)

14:00 Zihua Guo (Monash University)
Uniform estimates for oscillatory integrals with parameter-dependent phases
08-257 (p. 107)

14:30 Anh Bui (Macquarie University)
On Hermite pseudo–multipliers revisited
08-257 (p. 107)

15:00 Zijun Chen (Monash University)
Local well-posedness for dispersion generalized Benjamin-Ono equations in Fourier-Lebesgue spaces
08-257 (p. 107)

▷ Fri 8 December

13:30 Adam Sikora (Macquarie University)
Hardy spaces meet harmonic weights revisited
08-257 (p. 109)

14:00 Bingyang Hu (None)
On the curved trilinear Hilbert transform
08-257 (p. 108)

14:30 Daniel Hauer (The University of Sydney)
Bernstein functional calculus and a generalized Helmholtz problem
08-257 (p. 108)

Session 12: Modern Techniques in Financial Mathematics

Organisers: Duy-Minh Dang, Kazutoshi Yamazaki

Contributed Talks

▷ Wed 6 December

13:30 Zhou Zhou (The University of Sydney)
Stability of Equilibria in Time-inconsistent Stopping Problems
03-314 (p. 113)

14:00 Libo Li (University of New South Wales)
Vulnerable European and American Options in a Market Model with Optional Hazard Process
03-314 (p. 111)

15:00 Chang Chen (The University of Queensland)
Mean-bPOE Portfolio Optimization
03-314 (p. 110)

16:00 Yunxi Xu (Monash University)
Strong solutions of mean-field FBSDEs with measurable coefficients and their applications to multi-population mean-field game
03-314 (p. 112)

16:30 Yaowen Lu (None)
A semi-Lagrangian ε-monotone Fourier method for continuous withdrawal GMWBs under jump-diffusion with stochastic interest rate
03-314 (p. 112)

17:00 Hao Zhou (The University of Queensland)
Monotone piecewise constant control integration schemes for the two-factor uncertain volatility model
03-314 (p. 112)

▷ Thu 7 December

13:30 Ivan Guo (Monash University)
An Efficient Frontier of Wealth Distributions with Connections to Utility Maximisation
03-314 (p. 111)

14:00 Yuyu Chen (The University of Melbourne)
An unexpected stochastic dominance: Pareto distributions, catastrophes, and risk exchange
03-314 (p. 110)

14:30 Tomonori Nakatsu (Shibaura Institute of Technology)
Computation of the Greeks of barrier options
03-314 (p. 112)

15:00 Kaustav Das (Monash University)
On Stochastic Partial Differential Equations and their applications to Derivative Pricing through a conditional Feynman-Kac formula
03-314 (p. 111)

▷ Fri 8 December

14:30 Haejun Jeon (Tokyo University of Science)
Time-to-build, regulation, and investment
03-314 (p. 111)

15:00 Duy-Minh Dang (The University of Queensland)
Fourier Neural Network Approximation of Transition Densities in Finance
03-314 (p. 110)

Session 13: Mathematical Physics

Organisers: Johanna Knapp, Ian Marquette, Gabriele Tartaglino Mazzucchelli

Contributed Talks

▷ Tue 5 December

13:30 Lachlan Bennett (The University of Queensland)
Occupancy probabilities in superintegrable bosonic networks
05-213 (p. 113)

14:00 Joshua Celeste (The University of Adelaide)
The topology of knotted semimetals
05-213 (p. 114)

14:30 Anthony Parr (The University of Queensland)
Super-integrability and Deformed Oscillator Realisations of Quantum TTW Hamiltonians on Constant-Curvature Manifolds and with Reflections in a Plane
05-213 (p. 117)

15:00 Saurish Khandelwal (The University of Queensland)
All gauged curvature-squared invariants of mininal (N=1) supergravity in five dimensions
05-213 (p. 116)

16:00 Gregory Gold (The University of Queensland)
A Functional Approach to Cosmological Particle Production
05-213 (p. 114)

16:30 William Mead (The University of Melbourne)
Integrable half space exclusion process and diagonally symmetric alternating sign matrices I
05-213 (p. 116)

17:00 Jan De Gier (The University of Melbourne)
Integrable half space exclusion process and diagonally symmetric alternating sign matrices
05-213 (p. 114)

▷ Wed 6 December

14:00 Mitchell Jones (The University of Queensland)
Transfer Matrices of Gaudin superalgebras
05-213 (p. 115)

14:30 Madeline Nurcombe (The University of Queensland)
An isomorphism of diagram algebras
05-213 (p. 117)

15:00 Jaco van Tonder (The University of Queensland)
Integrable spin-1/2 XY central spin models
05-213 (p. 118)

16:00 Christian Kennedy (The University of Queensland)
6D $\mathcal{N} = (2, 0)$ Conformal Supergravity
05-213 (p. 115)

16:30 Liam Smith (The University of Queensland)
New Deformations of Quantum Field Theories
05-213 (p. 117)

17:00 Ming Chen (The University of Queensland)
Exact solution for Hawking radiation and wave scattering of charged massless scalar field by the charged C-metric black hole
05-213 (p. 114)

▷ Thu 7 December

13:30 Nalini Joshi (The University of Sydney)
Birational maps through the lens of cryptography
05-213 (p. 115)

14:00 Harini Desiraju (The University of Sydney)

Modular transformation of the toric conformal blocks
05-213 (p. 114)

14:30 Thao Thuan Vu Ho (Monash University)
Hamiltonian approach to 2-layer density stratified fluids.
05-213 (p. 118)

15:00 Ian Marquette (The University of Queensland)
Polynomial algebras from Lie algebra reduction chains $\mathfrak{g} \supset \mathfrak{g}'$
05-213 (p. 116)

▷ Fri 8 December

13:30 Jean-Emile Bourgine (The University of Melbourne)
A (q,t)-deformation of the Toda integrable hierarchy
05-213 (p. 113)

14:00 Alexander Sherman (The University of Sydney)
Queer Kac-Moody algebras and an so(3) superconformal algebra
05-213 (p. 117)

14:30 Yang Zhang (The University of Queensland)
Einstein metrics on homogeneous superspaces
05-213 (p. 118)

15:00 Jon Links (The University of Queensland)
An unsolvable case of Yang-Baxter integrability
05-213 (p. 116)

Session 14: Mathematics Education

Organisers: Poh Hillock, Michael Jennings, carolyn kennett, Greg Oates, Leesa Sidhu, Chris Tisdell

Contributed Talks

▷ Tue 5 December

13:30 Miguel Goberna (University of Alicante)
Maths in Politics
69-401 (p. 119)

14:00 TriThang Tran (The University of Melbourne)
What mathematical communication means to first year students
69-401 (p. 121)

14:30 Chris Tisdell (University of New South Wales)
Fostering Students to Think Like a Mathematician: Counting and Complexity in Geometry
69-401 (p. 120)

15:00 Adam Piggott (Australian National University)
An assessment plan for the first year mathematics at ANU
69-401 (p. 120)

16:00 Raymond Vozzo (The University of Adelaide)
An assessment of active learning in large first year maths courses
69-401 (p. 121)

16:30 Sam Kault (The University of Queensland)
Mastery learning in first year maths
69-401 (p. 119)

▷ Thu 7 December

13:30 Paul Fijn (The University of Melbourne)
Rethinking Statistics Computer Lab Classes
69-401 (p. 119)

14:00 Leesa Sidhu (University of New South Wales Canberra)
Supporting Students AND Tutors in the Maths and Stats Classroom
69-401 (p. 120)

14:30 Matthew Paul Skerritt (RMIT University)
Divergent Assessment in Undergraduate Mathematics
69-401 (p. 120)

Session 15: Number Theory

Organisers: Bryce Kerr

Contributed Talks

▷ Tue 5 December

13:30 Nicol Leong (UNSW Canberra)
Lower bounds on the zeta function
01-E212 (p. 122)

14:00 Andrew Yang (UNSW Canberra)
On optimal exponent pairs
01-E212 (p. 123)

14:30 Chiara Bellotti (UNSW Canberra)
Explicit zero density estimate near unity
01-E212 (p. 122)

15:00 Muhammad Afifurrahman (UNSW Sydney)
Arithmetic statistics of rational matrices of bounded height
01-E212 (p. 121)

16:00 Christian Bagshaw (University of New South Wales)
Sequences of Irreducible Polynomials
01-E212 (p. 121)

16:30 Dion Nikolic (UNSW Canberra)
Counting the Number and Dimension of Classes of Matrix Solutions for a Given Polynomial
01-E212 (p. 123)

▷ Wed 6 December

15:00 Kevin Fergusson (Bond University)
Differential Equations Satisfied by Modular Forms
01-E212 (p. 122)

16:00 Nikita Shulga (La Trobe University)
Racidal bound for Zaremba's conjecture
01-E212 (p. 123)

16:30 Mumtaz Hussain (La Trobe University)
Continued fractions and Diophantine approximation
01-E212 (p. 122)

17:00 Aleksander Simonic (University of New South Wales Canberra)
Some conditional estimates for functions in the Selberg class
01-E212 (p. 123)

▷ Thu 7 December

13:30 Adrian Dudek (The University of Queensland)
Prime Numbers in Short Intervals on RH
01-E212 (p. 122)

14:00 Timothy Trudgian (UNSW Canberra)
Defrosting Ingham's frozen theorem for zeta
01-E212 (p. 123)

14:30 Bryce Kerr (UNSW Canberra)
Coppersmith's method in many variables
01-E212 (p. 122)

Session 16: Optimisation

Organisers: Minh N. Dao, Matthew Tam

Contributed Talks

▷ Tue 5 December

13:30 Samir Adly (University of Limoges)
Enhancing Sensitivity Analysis for Monotone Inclusions Through Proto-Differentiability of the Resolvent Operator.
14-116 (p. 124)

14:00 Janosch Rieger (Monash University)
Generalised Gearhart-Koshy acceleration is a Krylov space method
14-116 (p. 127)

14:30 Oscar Smee (The University of Queensland)
Inexact Newton's method for non-convex constrained optimization
14-116 (p. 128)

15:00 Kerry He (Monash University)
Convex Optimization Methods in Quantum Information Theory
14-116 (p. 126)

16:00 Regina S. Burachik (University of South Australia)
Optimal Control Duality and the Douglas–Rachford Algorithm
14-116 (p. 125)

16:30 Mahdi Abolghasemi (The University of Queensland)
Approximating Solutions to the Knapsack Problem using the Lagrangian Dual Framework
14-116 (p. 124)

17:00 Yongjia Yuan (Federation University Australia)
Clustering data streams using an adaptive cluster-preserving approach
14-116 (p. 129)

▷ Wed 6 December

13:30 Miguel Goberna (University of Alicante)
Duality and limiting formulas for convex infinite optimization problems
14-116 (p. 125)

14:00 Yingkun (Queenie) Huang (University of New South Wales)
Second-Order Cone Programs for Distributionally Robust Optimisation, with Applications to Revenue Maximisation and Insurance Claims Management
14-116 (p. 126)

14:30 Huyen Duong (University of New South Wales)
Robust Solutions of Single-Leader-Multi-Follower Games
14-116 (p. 125)

15:00 Tan Pham (Federation University Australia)
Minimizing a separable sum coupled by a difference of functions and linear constraints
14-116 (p. 127)

16:00 Yalcin Kaya (University of South Australia)
Infeasible Optimal Control Problems
14-116 (p. 126)

16:30 Daniel Uteda (The University of Melbourne)
Active Support Identification for Finite Max Functions
14-116 (p. 128)

17:00 Thakshila Rajapaksha (University of Wollongong)
Linear convergence of tilt-correct DFO proximal bundle method
14-116 (p. 127)

▷ Thu 7 December

13:30 Nadia Sukhorukova (Swinburne University of Technology)
Deep learning and its mathematical nature
14-116 (p. 128)

14:30 Fred Roosta (The University of Queensland)
A Newton-MR Algorithm With Complexity Guarantees for Nonconvex Optimization
14-116 (p. 128)

15:00 Vinesha Peiris (Curtin University)
A comparison of rational and neural network based approximations
14-116 (p. 127)

▷ Fri 8 December

13:30 Hong-Kun Xu (Hangzhou Dianzi University)
Extra-anchored Halpern Iteration and Applications in Variational Inequalities
14-116 (p. 129)

14:30 Thi Hoa Bui (Curtin University)
Cutting Plane Algorithms are Exact for Euclidean Max-Sum Problems
14-116 (p. 124)

15:00 Reinier Diaz Millan (Deakin University)
Extragradient method with feasible inexact projection to variational inequality problem
14-116 (p. 125)

Session 17: Partial Differential Equations

Organisers: Serena Dipierro, Giorgio Poggesi, Enrico Valdinoci

Contributed Talks

▷ Tue 5 December

13:30 Florica Corina Cirstea (The University of Sydney)
Boundedness of solutions to singular anisotropic elliptic equations
08-257 (p. 129)

14:00 Jiakun Liu (University of Wollongong)
How does the free boundary touch the fixed boundary
08-257 (p. 132)

14:30 Brian Krummel (The University of Melbourne)
A planar frequency function for area minimizing currents
08-257 (p. 131)

15:00 James Larsen-Scott (Monash University)
Spectral Optimisation of the Robin Laplacian on Quadrilaterals
08-257 (p. 131)

▷ Wed 6 December

16:00 Jack Thompson (The University of Western Australia)
Some nonlocal geometric identities with applications to classical formulas in Riemannian geometry
08-257 (p. 132)

16:30 Ruixuan Zhu (Australian National University)
Parabolic Monge-Ampère equations without concavity
08-257 (p. 133)

17:00 ABHILASH TUSHIR (None)
DISCRETE HEAT EQUATION WITH IRREGULAR THERMAL CONDUCTIVITY AND TEMPERED DISTRIBUTIONAL DATA
08-257 (p. 132)

▷ Thu 7 December

13:30 Daniel Hauer (The University of Sydney)
An extension problem for the logarithmic Laplacian
08-257 (p. 130)

14:00 Kwok-Kun Kwong (University of Wollongong)
Inverse curvature flow and two families of weighted geometric inequalities involving three quantities
08-257 (p. 131)

14:30 Jesse Gell-Redman (None)
New perspectives in scattering for nonlinear evolution equations
08-257 (p. 130)

15:00 Rong Wang (The Australian National University)
Long-time dynamics of an diffusive epidemic model with free boundaries
08-257 (p. 132)

▷ Fri 8 December

15:00 Artem Pulemotov (The University of Queensland)
Hermitian metrics with vanishing second Chern Ricci curvature
08-257 (p. 132)

16:00 Glen Edward Wheeler (University of Wollongong)
The Entropy Flow
08-257 (p. 133)

16:30 Yihong Du (University of New England)
Rate of acceleration in propagation of the KPP equation with nonlocal diffusion and free boundaries
08-257 (p. 130)

Session 18: Probability and Mathematical Statistics

Organisers: Andrea Collevecchio, Andriy Olenko

Contributed Talks

▷ Tue 5 December

13:30 Kais Hamza (Monash University)
A deterministic walk on the randomly oriented Manhattan lattice
03-320 (p. 135)

14:00 Andrea Collevecchio (Monash University)
Localization of Vertex Reiinforced Jump Processes
03-320 (p. 133)

14:30 Simon Harris (University of Auckland)
Genealogies of samples from stochastic population models
03-320 (p. 135)

15:00 Laurence Field (Australian National University)
Brownian motion and permeable boundaries
03-320 (p. 134)

16:00 Zehua Zang (The University of Auckland)
Branching processes with detection
03-320 (p. 139)

16:30 binghao wu (None)
The derivative of Brownian motion localtimes
03-320 (p. 139)

17:00 Aram Perez (Monash University)
Stein's Method in Statistical Mechanics
03-320 (p. 137)

▷ Wed 6 December

13:30 Ross Maller (Australian National University)
Asymptotics of the Allele Frequency Spectrum and the Number of Alleles
03-320 (p. 136)

14:00 Xi Geng (The University of Melbourne)
Expected signature on Riemannian manifolds and its geometric implications
03-320 (p. 134)

14:30 Stephen Muirhead (The University of Melbourne)
Persistence of stationary Gaussian fields with spectral singularity
03-320 (p. 137)

15:00 Andriy Olenko (La Trobe University)
On Fractional Spherically Restricted Hyperbolic Diffusion Random Field
03-320 (p. 137)

16:00 Illia Donhauzer (La Trobe University)
Limit theorems for multifractal products of random fields
03-320 (p. 134)

16:30 Ksenia Sofronova (UNSW Sydney)
Optimal Sequential Decisions with Financial Applications
03-320 (p. 138)

17:00 Joseph Menesch (The University of Queensland)
Automated importance function estimation for adaptive multilevel splitting
03-320 (p. 136)

▷ Thu 7 December

13:30 Peter Gerrard Taylor (The University of Melbourne)
A General Framework for Modelling Hypnozoite Accrual and Superinfection in Malaria
03-320 (p. 138)

14:00 Aihua Xia (The University of Melbourne)
On the rate of normal approximation for Poisson continuum percolation
03-320 (p. 139)

14:30 Kihun Nam (Monash University)
Coupled FBSDEs with Measurable Coefficients and its Application to Parabolic PDEs
03-320 (p. 137)

▷ Fri 8 December

13:30 Geoffrey McLachlan (The University of Queensland)
A Surprising Result in Semi-Supervised Learning
03-320 (p. 136)

14:00 Jesse Goodman (University of Auckland)
Splitting the saddlepoint approximation across a sample path
03-320 (p. 135)

14:30 Pavel Krupskiy (The University of Melbourne)
Max-convolution processes with random shape indicator kernels
03-320 (p. 135)

15:00 Alysha De Livera (La Trobe University)
Multivariate meta-analysis methods for high-dimensional data
03-320 (p. 133)

16:00 David James Warne (Queensland University of Technology)
Multidelity multilevel Monte Carlo for approximate Bayesian computation
03-320 (p. 138)

16:30 Renjie Feng (The University of Sydney)
A graphical formula for cumulants of multivariate linear statistics of determinantal point processes.
03-320 (p. 134)

17:00 Kazutoshi Yamazaki (The University of Queensland)
Lévy bandits under Poissonian decision times
03-320 (p. 139)

Session 19: Stochastic Differential Equations

Organisers: Beniamin Goldys, Ngan Le

Contributed Talks

▷ Tue 5 December

13:30 Akash Ashirbad Panda (Indian Institute of Technology Bhubaneswar)
Higher order time discretization for the stochastic semilinear wave equation with multiplicative noise
03-315 (p. 142)

14:00 Chunxi Jiao (RWTH Aachen University)
On the thin-film limit of stochastic Landau-Lifshitz equation
03-315 (p. 141)

14:30 Muhammad Awais Khan (Monash University)
Numerical analysis of stochastic Stefan problem
03-315 (p. 141)

15:00 SHIJIA JIN (Monash University)
Market making, FBSDE, and BSRE
03-315 (p. 141)

16:00 Libo Li (University of New South Wales)
Parametrix Method for Skew Diffusion and its Local Time
03-315 (p. 142)

16:30 Zhewen Feng (The University of Queensland)
Existence of solutions to the stochastic Ericksen-Leslie system in a 3-D bounded domain
03-315 (p. 140)

17:00 Jörn Wichmann (Monash University)
A class of space-time discretizations for the stochastic p-Stokes system
03-315 (p. 143)

▷ Thu 7 December

13:30 Erika Hausenblas (Montanuniversitaet Leoben)
A stochastic bidomain model with Gaussian and pure Lévy noise
03-315 (p. 140)

14:00 Beniamin Goldys (The University of Sydney)
Erika Hausenblas: A stochastic bidomain model with Gaussian and pure Levy noise, part II
03-315 (p. 140)

14:30 Ruyi Liu (The University of Sydney)
Pairs Trading: An Optimal Selling Rule with Constraints
03-315 (p. 142)

▷ Fri 8 December

13:30 Quoc Thong Le Gia (University of New South Wales)
Discretisation of a class of semilinear stochastic PDEs on the unit sphere and invariant measures
03-315 (p. 142)

14:00 Jie Yen Fan (Monash University)
Measure-valued processes and stochastic partial differential equations
03-315 (p. 140)

16:00 Debopriya Mukherjee (Indian Institute of Technology Indore)
A shape Calculus Approach for time harmonic solid - fluid interaction problem in stochastic domains
03-315 (p. 142)

16:30 Ngan Le (Monash University)
Stochastic perturbation vs variance of solutions to stochastic PDEs
03-315 (p. 141)

Session 20: Representation Theory

Organisers: Sam Jeralds, Ian Le, Bregje Pauwels, Anna Romanov

Contributed Talks

▷ Tue 5 December

13:30 Kevin Coulembier (The University of Sydney)
N-spherical functors and tensor categories
02-D114 (p. 143)

14:30 Jackson Ryder (UNSW Sydney)
Noncommutative affine curves and regular representations of affine Dynkin graphs
02-D114 (p. 145)

15:00 Gavrilo Šipka (The University of Queensland)
Yangians: their truncations and representation theory
02-D114 (p. 147)

16:00 Alexander Sherman (The University of Sydney)
Sylow subgroups of supergroups
02-D114 (p. 146)

16:30 Eloise Little (The University of Sydney)
Using alcove path combinatorics to identify Kazhdan-Lusztig cells
02-D114 (p. 145)

17:00 Seamus Albion (University of Vienna)
Littlewood's decomposition and character factorisations
02-D114 (p. 143)

▷ Wed 6 December

13:30 Yau Wing Li (The University of Melbourne)
Endoscopy for affine Hecke categories
02-D114 (p. 145)

14:00 Dougal Davis (The University of Melbourne)
Unitary representations and localisation for Hodge modules
02-D114 (p. 144)

14:30 Stefano Giannini (The University of Queensland)
Additive character varieties
02-D114 (p. 144)

15:00 Bailey Whitbread (The University of Queensland)
Polynomials in the variable q
02-D114 (p. 146)

16:00 Konstantin Jakob (TU Darmstadt)
Stokes phenomenon of Kloosterman connections
02-D114 (p. 144)

16:30 Dilshan Wijesena (University of New South Wales)
Classifying representations of the Thompson groups and the Cuntz algebra
02-D114 (p. 146)

17:00 Dragan Milicic (None)
A formula for n-homology and its application
02-D114 (p. 145)

▷ Thu 7 December

13:30 Jieru Zhu (None)
M-diagram bases of the Specht module for three row partitions
02-D114 (p. 147)

14:00 Justine Fasquel (The University of Melbourne)
Building blocks for W-algebras
02-D114 (p. 144)

14:30 Ian Le (Australian National University)
Cluster Structures on Braid Varieties
02-D114 (p. 144)

15:00 Geordie Williamson (None)
4-Strand Burau is Unfaithful Modulo 5
02-D114 (p. 146)

▷ Fri 8 December

14:00 Peter McNamara (The University of Melbourne)
The Spin Brauer Category
02-D114 (p. 145)

14:30 Travis Scrimshaw (Hokkaido University)
Representations of twisted quantum Clifford algebras
02-D114 (p. 146)

Session 21: Topology

Organisers: Diarmuid Crowley, Pedram Hekmati, Daniel Mathews

Contributed Talks

▷ Tue 5 December

13:30 Em Thompson (Monash University)
An algorithm to construct one-vertex triangulations of Heegaard splittings
01-E215 (p. 151)

14:00 Finn Thompson (The University of Queensland)
Computing Heegaard Genus of 3-Manifolds
01-E215 (p. 152)

14:30 Connie On Yu HUI (Monash University)
A complete classification of rod complements in the 3-torus
01-E215 (p. 150)

15:00 Rhuaidi Burke (The University of Queensland)
Developments in computational 4-manifold topology
01-E215 (p. 148)

16:00 Lucy Tobin (The University of Sydney)
Vertex Numbers of 4-Manifold Triangulations
01-E215 (p. 152)

16:30 MUSASHI KOYAMA (Australian National University)
Reduced Vietoris Rips complexes: A faster way to compute PH_1
01-E215 (p. 150)

17:00 Christian Degnbol Madsen (The University of Melbourne)
The Topological Properties of the Protein Universe
01-E215 (p. 150)

▷ Wed 6 December

13:30 Grace Garden (The University of Sydney)
Character varieties and essential surfaces in arbitrary characteristic
01-E215 (p. 149)

14:00 Lecheng Su (Monash University)
Alternating links on non-orientable surfaces
01-E215 (p. 151)

14:30 Alexander He (The University of Queensland)
The triangulation complexity of satellite knots
01-E215 (p. 149)

15:00 James Morgan (The University of Sydney)
On the complexity of two-bridge link complements
01-E215 (p. 151)

16:00 Xavier Coulter (University of Auckland)
A one-parameter deformation of the monotone Hurwitz numbers
01-E215 (p. 149)

16:30 Lukas Anagnostou (The University of Melbourne)
Weil-Petersson volumes, stability conditions and wall-crossing
01-E215 (p. 147)

17:00 Orion Zymaris (Monash University)
Spinors and DescartesŤheorem
01-E215 (p. 152)

▷ Thu 7 December

13:30 Agnese Barbensi (The University of Queensland)
Topological Optimal Transport and Geometric Cycle Matchings
01-E215 (p. 147)

14:00 Yossi Bokor Bleile (Aalborg University)
Topology, geometry and microstructures
01-E215 (p. 148)

14:30 Marcy Robertson (The University of Melbourne)
Towers of Kashiwara-Vergne Solutions
01-E215 (p. 151)

15:00 Finnur Larusson (The University of Adelaide)
Homotopy theory in the theory of minimal surfaces
01-E215 (p. 150)

▷ Fri 8 December

13:30 Marcos Orseli (The University of Adelaide)
Equivariant index on toric contact manifolds
01-E215 (p. 151)

14:00 Rod Gover (University of Auckland)
Some progress on the ASD deformation complex
01-E215 (p. 149)

14:30 Stephan Tillmann (The University of Sydney)
Slope norm, crosscap number and complexity of Dehn fillings
01-E215 (p. 152)

15:00 Joshua Howie (Monash University)
Free spanning surfaces which are not isotopic to state surfaces
01-E215 (p. 149)

16:00 Daniele Celoria (The University of Melbourne)
A q-hypergeometric approach to the 3D index
01-E215 (p. 148)

16:30 Benjamin Burton (The University of Queensland)
Parallelism in topological algorithms
01-E215 (p. 148)

Conference Days

Conference Day 1: Tue 5 December

Summary timetable

When	What
09:00–11:00	2 special session talks
11:30–12:30	**Plenary:** Peluse – Arithmetic patterns in dense sets (p. 71)
12:30–13:30	**Event:** Sponsor presentation 1 (Optiver)
13:30–14:00	15 special session talks
14:00–14:30	15 special session talks
14:30–15:00	15 special session talks
15:00–15:30	15 special session talks
16:00–16:30	14 special session talks
16:30–17:00	14 special session talks
17:00–17:30	14 special session talks
17:30–18:30	**Plenary:** De Lellis – Area-minimizing integral currents: singularities and structure (p. 70)
18:30–20:00	**Event:** Welcome drinks

Non-plenary Sessions

. 2 Applied and Industrial Mathematics

13:30 Matthew Holden (The University of Queensland)
Quantifying the value of data and models for environmental management
14-115 (p. 74)

14:00 Liam Timms (The University of Melbourne)
Saving elephants with rangers and real estate: optimizing conservation funding
14-115 (p. 77)

14:30 Thomas Taimre (The University of Queensland)
Rare-event simulation techniques for structured fisheries models
14-115 (p. 77)

15:00 Aaron Thornton (CSIRO)
Modelling Intrinsically Disordered Proteins using Mechanical Hoberman Spheres
14-115 (p. 77)

16:00 Mark Flegg (Monash University)
Modelling of a Tomato Glasshouse
14-115 (p. 74)

16:30 Ruethaichanok Kardkasem (The University of Queensland)
Extreme Precipitation on the Eastern Coast of Australia
14-115 (p. 75)

17:00 Jason Mackellar (The University of Newcastle)
Towards an algorithm for the de-convolution of fractionation data
14-115 (p. 75)

. 3 Category Theory, Homotopy Theory, and K-Theory

13:30 Fei Peng (The University of Melbourne)
Fourier–Mukai transforms for Deligne–Mumford stacks
03-262 (p. 81)

14:00 Joshua Graham (University of New South Wales)
Equivariant Motivic Cohomology and it's relationship to Bredon Cohomology
03-262 (p. 80)

14:30 Alexander Clark (The University of Melbourne)
Classifying t-structures on filtered tensor-triangulated categories
03-262 (p. 79)

15:00 Bill Deng (UNSW Sydney)
The $RO(G)$-graded cohomology of $E_{\Sigma_2}C_2$
03-262 (p. 79)

16:00 Jayden Hammet (The University of Melbourne)
U_α-bordism: a refinement of complex bordism
03-262 (p. 80)

16:30 Olivia Borghi (The University of Melbourne)
Commutativity in Higher Algebraic Objects
03-262 (p. 78)

17:00 Kurt Stoeckl (The University of Melbourne)
Homotopy Probs and Other G-Operadic Structures.
03-262 (p. 82)

. 5 Computational Mathematics

13:30 Connor Mallon (Monash University)
Neural Level Set Topology Optimisation using Unfitted Finite Elements
03-309 (p. 89)

14:00 Andres Eduardo Rubiano Martinez (Monash University)
Virtual element methods for coupled stress-assisted diffusion problems
03-309 (p. 90)

14:30 Zachary James Wegert (Queensland University of Technology)
A Hilbertian projection method for constrained level set-based topology optimisation
03-309 (p. 92)

15:00 Matthew Paul Skerritt (RMIT University)
Computing and Optimising Fisher Information for Partially Observable Simple Birth Processes
03-309 (p. 90)

16:00 Mst Shanta Khatun (The University of Sydney)
Mathematical Modelling of Cancer Evolution
03-309 (p. 86)

16:30 Wei Li (Monash University)
Finite element interpolated neural networks for solving forward and inverse problems
03-309 (p. 88)

17:00 Cristian Inzunza (Universidad de Concepcion)
A Banach spaces-based fully-mixed finite element method for the coupled poroelasticity and Poisson–Nernst–Planck equations
03-309 (p. 86)

. 6 Dynamical Systems and Ergodic Theory

13:30 Jason Atnip (The University of Queensland)
Universal Gap Growth for Lyapunov Exponents of Perturbed Matrices
35-519 (p. 92)

14:00 Sakshi Jain (None)
Piecewise Contracting Systems

35-519 (p. 93)

14:30 Amal Al Dowais (The University of Western Australia)
Lyapunov exponents for open billiard flows
35-519 (p. 92)

15:00 Joshua Peters (None)
Prevalence of stability for smooth Blaschke product cocycles fixing the origin
35-519 (p. 94)

. 8 Functional Analysis

16:00 ()
35-519 (p. **??**)

16:30 ()
35-519 (p. **??**)

17:00 Jimeng Lu (None)
Pisier's Question: Steinberg Theorem Revisited
35-519 (p. 98)

. 9 Geometric Analysis

16:00 Kyle Broder (The University of Queensland)
A Locality Theorem for Einstein Metrics on Compact Complex Manifolds
08-212 (p. 99)

16:30 James Stanfield (The University of Queensland)
Pluriclosed Metrics with Negative Holomorphic Sectional Curvature
08-212 (p. 101)

17:00 Adam Thompson (The University of Queensland)
Ricci solitons with non-compact symmetry
08-212 (p. 102)

. 10 Algebra and Combinatorics

13:30 George Willis (The University of Newcastle)
Scale groups
01-E302 (p. 106)

14:00 Adam Piggott (Australian National University)
Quasi-transitive geodetic graphs Part I
01-E302 (p. 105)

14:30 Kane Townsend (University of Technology Sydney)
Quasi-transitive geodetic graphs Part II
01-E302 (p. 106)

15:00 Murray Elder (University of Technology Sydney)
On the complexity of epimorphism testing with virtually abelian targets
01-E302 (p. 103)

16:00 Roman Gorazd (The University of Newcastle)
Higman Thompson groups and Leavitt path algebras of graphs
01-E302 (p. 103)

16:30 Matthias Fresacher (Western Sydney University)
Congruence Lattices of Finite Twisted Brauer Monoids
01-E302 (p. 103)

17:00 Samuel Barton (The University of Queensland)
A new classification model based on a population of hypergraphs
01-E302 (p. 102)

. 11 Harmonic Analysis

13:30 Sanghyuk Lee (Seoul National University)
L^p bounds on the strong spherical maximal functions
08-212 (p. 109)

14:00 Ji Li (Macquarie University)
Some recent progress on analysis on model domains
08-212 (p. 109)

14:30 Jeffrey Hogan (The University of Newcastle)
Clifford translations, splines and bandpass bases
08-212 (p. 108)

15:00 Fu Ken Ly (The University of Sydney)
Higher order Riesz transforms and almost diagonality for Hermite expansions
08-212 (p. 109)

. 13 Mathematical Physics

13:30 Lachlan Bennett (The University of Queensland)
Occupancy probabilities in superintegrable bosonic networks
05-213 (p. 113)

14:00 Joshua Celeste (The University of Adelaide)
The topology of knotted semimetals
05-213 (p. 114)

14:30 Anthony Parr (The University of Queensland)
Super-integrability and Deformed Oscillator Realisations of Quantum TTW Hamiltonians on Constant-Curvature Manifolds and with Reflections in a Plane
05-213 (p. 117)

15:00 Saurish Khandelwal (The University of Queensland)
All gauged curvature-squared invariants of mininal (N=1) supergravity in five dimensions
05-213 (p. 116)

16:00 Gregory Gold (The University of Queensland)
A Functional Approach to Cosmological Particle Production
05-213 (p. 114)

16:30 William Mead (The University of Melbourne)
Integrable half space exclusion process and diagonally symmetric alternating sign matrices I
05-213 (p. 116)

17:00 Jan De Gier (The University of Melbourne)
Integrable half space exclusion process and diagonally symmetric alternating sign matrices
05-213 (p. 114)

. 14 Mathematics Education

13:30 Miguel Goberna (University of Alicante)
Maths in Politics
69-401 (p. 119)

14:00 TriThang Tran (The University of Melbourne)
What mathematical communication means to first year students
69-401 (p. 121)

14:30 Chris Tisdell (University of New South Wales)
Fostering Students to Think Like a Mathematician: Counting and Complexity in Geometry
69-401 (p. 120)

15:00 Adam Piggott (Australian National University)
An assessment plan for the first year mathematics at ANU
69-401 (p. 120)

16:00 Raymond Vozzo (The University of Adelaide)
An assessment of active learning in large first year maths courses
69-401 (p. 121)

16:30 Sam Kault (The University of Queensland)
Mastery learning in first year maths
69-401 (p. 119)

17:00 ()
69-401 (p. **??**)

. 15 Number Theory

13:30 Nicol Leong (UNSW Canberra)
Lower bounds on the zeta function
01-E212 (p. 122)

14:00 Andrew Yang (UNSW Canberra)
On optimal exponent pairs
01-E212 (p. 123)

14:30 Chiara Bellotti (UNSW Canberra)
Explicit zero density estimate near unity
01-E212 (p. 122)

15:00 Muhammad Afifurrahman (UNSW Sydney)
Arithmetic statistics of rational matrices of bounded height
01-E212 (p. 121)

16:00 Christian Bagshaw (University of New South Wales)
Sequences of Irreducible Polynomials
01-E212 (p. 121)

16:30 Dion Nikolic (UNSW Canberra)
Counting the Number and Dimension of Classes of Matrix Solutions for a Given Polynomial
01-E212 (p. 123)

17:00 ()
01-E212 (p. **??**)

. 16 Optimisation

13:30 Samir Adly (University of Limoges)
Enhancing Sensitivity Analysis for Monotone Inclusions Through Proto-Differentiability of the Resolvent Operator.
14-116 (p. 124)

14:00 Janosch Rieger (Monash University)
Generalised Gearhart-Koshy acceleration is a Krylov space method
14-116 (p. 127)

14:30 Oscar Smee (The University of Queensland)
Inexact Newton's method for non-convex constrained optimization
14-116 (p. 128)

15:00 Kerry He (Monash University)
Convex Optimization Methods in Quantum Information Theory
14-116 (p. 126)

16:00 Regina S. Burachik (University of South Australia)
Optimal Control Duality and the Douglas–Rachford Algorithm
14-116 (p. 125)

16:30 Mahdi Abolghasemi (The University of Queensland)
Approximating Solutions to the Knapsack Problem using the Lagrangian Dual Framework
14-116 (p. 124)

17:00 Yongjia Yuan (Federation University Australia)

Clustering data streams using an adaptive cluster-preserving approach
14-116 (p. 129)

. 17 Partial Differential Equations

13:30 Florica Corina Cirstea (The University of Sydney)
Boundedness of solutions to singular anisotropic elliptic equations
08-257 (p. 129)

14:00 Jiakun Liu (University of Wollongong)
How does the free boundary touch the fixed boundary
08-257 (p. 132)

14:30 Brian Krummel (The University of Melbourne)
A planar frequency function for area minimizing currents
08-257 (p. 131)

15:00 James Larsen-Scott (Monash University)
Spectral Optimisation of the Robin Laplacian on Quadrilaterals
08-257 (p. 131)

. 18 Probability and Mathematical Statistics

13:30 Kais Hamza (Monash University)
A deterministic walk on the randomly oriented Manhattan lattice
03-320 (p. 135)

14:00 Andrea Collevecchio (Monash University)
Localization of Vertex Reiinforced Jump Processes
03-320 (p. 133)

14:30 Simon Harris (University of Auckland)
Genealogies of samples from stochastic population models
03-320 (p. 135)

15:00 Laurence Field (Australian National University)
Brownian motion and permeable boundaries
03-320 (p. 134)

16:00 Zehua Zang (The University of Auckland)
Branching processes with detection
03-320 (p. 139)

16:30 binghao wu (None)
The derivative of Brownian motion localtimes
03-320 (p. 139)

17:00 Aram Perez (Monash University)
Stein's Method in Statistical Mechanics
03-320 (p. 137)

. 19 Stochastic Differential Equations

13:30 Akash Ashirbad Panda (Indian Institute of Technology Bhubaneswar)
Higher order time discretization for the stochastic semilinear wave equation with multiplicative noise
03-315 (p. 142)

14:00 Chunxi Jiao (RWTH Aachen University)
On the thin-film limit of stochastic Landau-Lifshitz equation
03-315 (p. 141)

14:30 Muhammad Awais Khan (Monash University)
Numerical analysis of stochastic Stefan problem
03-315 (p. 141)

15:00 SHIJIA JIN (Monash University)
Market making, FBSDE, and BSRE
03-315 (p. 141)

16:00 Libo Li (University of New South Wales)
Parametrix Method for Skew Diffusion and its Local Time
03-315 (p. 142)

16:30 Zhewen Feng (The University of Queensland)
Existence of solutions to the stochastic Ericksen-Leslie system in a 3-D bounded domain
03-315 (p. 140)

17:00 Jörn Wichmann (Monash University)
A class of space-time discretizations for the stochastic p-Stokes system
03-315 (p. 143)

. 20 Representation Theory

13:30 Kevin Coulembier (The University of Sydney)
N-spherical functors and tensor categories
02-D114 (p. 143)

14:00 ()
02-D114 (p. **??**)

14:30 Jackson Ryder (UNSW Sydney)
Noncommutative affine curves and regular representations of affine Dynkin graphs
02-D114 (p. 145)

15:00 Gavrilo Šipka (The University of Queensland)
Yangians: their truncations and representation theory
02-D114 (p. 147)

16:00 Alexander Sherman (The University of Sydney)
Sylow subgroups of supergroups
02-D114 (p. 146)

16:30 Eloise Little (The University of Sydney)
Using alcove path combinatorics to identify Kazhdan-Lusztig cells
02-D114 (p. 145)

17:00 Seamus Albion (University of Vienna)
Littlewood's decomposition and character factorisations
02-D114 (p. 143)

. 21 Topology

13:30 Em Thompson (Monash University)
An algorithm to construct one-vertex triangulations of Heegaard splittings
01-E215 (p. 151)

14:00 Finn Thompson (The University of Queensland)
Computing Heegaard Genus of 3-Manifolds
01-E215 (p. 152)

14:30 Connie On Yu HUI (Monash University)
A complete classification of rod complements in the 3-torus
01-E215 (p. 150)

15:00 Rhuaidi Burke (The University of Queensland)
Developments in computational 4-manifold topology
01-E215 (p. 148)

16:00 Lucy Tobin (The University of Sydney)
Vertex Numbers of 4-Manifold Triangulations
01-E215 (p. 152)

16:30 MUSASHI KOYAMA (Australian National University)
Reduced Vietoris Rips complexes: A faster way to compute PH_1
01-E215 (p. 150)

17:00 Christian Degnbol Madsen (The University of Melbourne)
The Topological Properties of the Protein Universe

01-E215 (p. 150)

Conference Day 2: Wed 6 December

Summary timetable

When	What
09:00–10:00	**Plenary:** Dullin – On the Stability of the 3-Body Problem (p. 70)
10:30–11:30	**Plenary:** Roney-Dougal – Counting groups (p. 72)
11:30–12:30	**Plenary:** Bartlett – Benign Overfitting (p. 70)
12:30–13:30	**Event:** LGBTQIA+ and Allies Lunch
13:30–14:00	15 special session talks
14:00–14:30	15 special session talks
14:30–15:00	15 special session talks
15:00–15:30	15 special session talks
16:00–16:30	12 special session talks
16:30–17:00	13 special session talks
17:00–17:30	12 special session talks
17:30–18:30	**Plenary:** Hillock – Transforming First Year Mathematics: opening doors to success (p. 71)
18:30–19:30	**Event:** AustMS Student Meeting

Non-plenary Sessions

. 2 Applied and Industrial Mathematics

13:30 Adriana Zanca (The University of Melbourne)
Cell differentiation architectures
14-115 (p. 78)

14:00 James Lefevre (The University of Queensland)
Optimal control of Multiple Myeloma assuming drug evasion and off-target effects
14-115 (p. 75)

14:30 Benitho Amaobi Ngwu (Federal University Oye Ekiti)
Geometric Singular Perturbation Approach to GlassNetworks
14-115 (p. 76)

15:00 Lucy Ham (The University of Melbourne)
Deterministic hares, and stochastic tortoises: the timing of cellular events
14-115 (p. 74)

16:30 Yining Ding (The University of Sydney)
Pricing and Hedging of Cross-Currency Basis Swaps Referencing Backward-Looking Rates
14-115 (p. 74)

17:00 Huansang Xu (The University of Sydney)
Equity Protection Swaps: A New Type of Risk Management Products for Pension Funds
14-115 (p. 78)

. 3 Category Theory, Homotopy Theory, and K-Theory

13:30 Nicola Di Vittorio (Macquarie University)
Introduction to the theory of 2-derivators
03-262 (p. 79)

14:00 Tamara Hogan (The University of Melbourne)
A knot theoretic interpretation of the Goldman-Turaev Lie bialgebra
03-262 (p. 80)

14:30 Chandan Singh (The University of Melbourne)
ON RELATIVE STRUCTURE OF VIRTUAL TANGLES
03-262 (p. 82)

15:00 Keisuke Hoshino (Kyoto University)
Double categories of relations relative to factorisation systems
03-262 (p. 80)

16:00 Raymond Vozzo (The University of Adelaide)
Rigid 2-gerbes and applications
03-262 (p. 82)

16:30 Diarmuid Crowley (The University of Melbourne)
Stably homeomorphic 4-manifolds
03-262 (p. 79)

. 4 Discrete Geometry

13:30 David Yost (Federation University Australia)
The excess degree of a polytope
01-E212 (p. 83)

14:00 Aholiab Tritama (Deakin University)
Ramsey number on the graphs of dual cyclic polytopes
01-E212 (p. 83)

14:30 Guillermo Pineda-Villavicencio (Deakin University)
Counting and analysing faces of convex polytopes
01-E212 (p. 83)

. 5 Computational Mathematics

13:30 Yijia Liu (Australian National University)
Optimal parameter analysis of PML model and application of multi-block strategy in efficient numerical simulation of 2D acoustic waves in unbounded domain
03-309 (p. 88)

14:00 Kenneth Duru (The Australian National University)
On entropy stable and mimetic discontinuous Galerkin finite element methods for the rotating thermal shallow water equations in complex geometries
03-309 (p. 85)

14:30 Tiangang Cui (The University of Sydney)
Scalable conditional transport maps using tensor trains
03-309 (p. 84)

15:00 Lei Shi (Fudan University)
Classification with Deep Neural Networks
03-309 (p. 90)

16:00 Gabriel Gatica (Universidad de Concepcion)
Banach spaces-based mixed finite element methods for the convective Brinkman–Forchheimer problem and its coupling with Darcy equation
03-309 (p. 85)

16:30 Sergio Carrasco (Universidad de Concepcion)
New mixed finite element methods for the coupled convective Brinkman-Forchheimer and double-diffusion equations
03-309 (p. 84)

17:00 Segundo Villa Fuentes (Monash University)

A new fully-mixed formulation for the Navier–Stokes/Darcy equations
03-309 (p. 91)

. 6 Dynamical Systems and Ergodic Theory

13:30 Natalia McAlister Caffarel (Monash University)
Computer-aided proofs for blenders
35-519 (p. 94)

14:00 Andrew Cook (Monash University)
Nowhere coexpanding functions
35-519 (p. 92)

14:30 Benjamin Ward (La Trobe University)
Irrational rotations in higher dimensions
35-519 (p. 95)

15:00 Marisa dos Reis Cantarino (Monash University)
u-Gibbs measure rigidity for uniformly expanding partially hyperbolic endomorphisms on surfaces
35-519 (p. 93)

. 7 Equity, Diversity and Inclusion in Mathematics

13:30 Liam Timms (The University of Melbourne)
Creating inclusive classrooms in mathematics
67-442 (p. 97)

14:00 Masoud Kamgarpour (The University of Queensland)
Can we communicate maths better?
67-442 (p. 96)

14:30 Nalini Joshi (The University of Sydney)
Vision for Equity, Diversity and Inclusion in the AustMS: past, current and future actions (Part I)
67-442 (p. 96)

15:00 Nalini Joshi (The University of Sydney)
Vision for Equity, Diversity and Inclusion in the AustMS: past, current and future actions (Part II)
67-442 (p. 96)

. 8 Functional Analysis

16:00 Farrell David (UNSW Sydney)
An Abstract Approach to Principal Symbol Calculus
35-519 (p. 98)

16:30 Angus Alexander (University of Wollongong)
An index pairing in scattering theory
35-519 (p. 98)

17:00 Hongyin Zhao (University of New South Wales)
Kuroda's theorem for n-tuples in semifinite factors
35-519 (p. 99)

. 9 Geometric Analysis

13:30 Jahne Meyer (The University of Newcastle)
Evolving polygons via semi-discrete polyharmonic geometric flows
08-212 (p. 101)

14:00 Mashniah Gazwani (The University of Newcastle)
Curvature diffusion of planar curves with generalised Neumann boundary conditions inside cones
08-212 (p. 99)

14:30 Marcus Flook (Australian National University)
Flows of real hypersurfaces immersed in complex space by Levi curvature

08-212 (p. 99)

15:00 Peter Olamide Olanipekun (The University of Auckland)
A Rigidity Result for Four Dimensional Willmore-type Submanifolds
08-212 (p. 101)

. 10 Algebra and Combinatorics

13:30 Erchuan Zhang (Edith Cowan University)
Antiregular k-hypergraph and independent polynomial
01-E302 (p. 107)

14:00 Sarah Lawson (The University of Queensland)
Tudisco and Higham's Nonlinear Eigenvector Centrality for Hypergraphs and its application to biological processes
01-E302 (p. 104)

14:30 Barbara Maenhaut (The University of Queensland)
A Family of Connected 1-Factorisations of Complete 3-Uniform Hypergraphs
01-E302 (p. 105)

15:00 Yudhistira Andersen Bunjamin (UNSW Sydney)
Using 4-GDDs to construct 3-GDDs
01-E302 (p. 102)

16:00 Chuanqi Zhang (University of Technology Sydney)
On linear-algebraic notions of expansion
01-E302 (p. 106)

16:30 Afsane Ghafari Baghestani (Monash University)
Construction of Latin squares with restricted transversals
01-E302 (p. 103)

17:00 Tara Kemp (The University of Queensland)
Latin hypercubes realizing integer partitions
01-E302 (p. 104)

. 11 Harmonic Analysis

13:30 Thangavelu Sundaram (Indian Institute of Science Bangalore)
On the range of Poisson transform on noncompact Riemannian symmetric spaces
08-257 (p. 110)

14:00 Zihua Guo (Monash University)
Uniform estimates for oscillatory integrals with parameter-dependent phases
08-257 (p. 107)

14:30 Anh Bui (Macquarie University)
On Hermite pseudo–multipliers revisited
08-257 (p. 107)

15:00 Zijun Chen (Monash University)
Local well-posedness for dispersion generalized Benjamin-Ono equations in Fourier-Lebesgue spaces
08-257 (p. 107)

. 12 Modern Techniques in Financial Mathematics

13:30 Zhou Zhou (The University of Sydney)
Stability of Equilibria in Time-inconsistent Stopping Problems
03-314 (p. 113)

14:00 Libo Li (University of New South Wales)
Vulnerable European and American Options in a Market Model with Optional Hazard Process
03-314 (p. 111)

14:30 ()
03-314 (p. **??**)

15:00 Chang Chen (The University of Queensland)
Mean-bPOE Portfolio Optimization
03-314 (p. 110)

16:00 Yunxi Xu (Monash University)
Strong solutions of mean-field FBSDEs with measurable coefficients and their applications to multi-population mean-field game
03-314 (p. 112)

16:30 Yaowen Lu (None)
A semi-Lagrangian ε-monotone Fourier method for continuous withdrawal GMWBs under jump-diffusion with stochastic interest rate
03-314 (p. 112)

17:00 Hao Zhou (The University of Queensland)
Monotone piecewise constant control integration schemes for the two-factor uncertain volatility model
03-314 (p. 112)

. 13 Mathematical Physics

13:30 ()
05-213 (p. ??)

14:00 Mitchell Jones (The University of Queensland)
Transfer Matrices of Gaudin superalgebras
05-213 (p. 115)

14:30 Madeline Nurcombe (The University of Queensland)
An isomorphism of diagram algebras
05-213 (p. 117)

15:00 Jaco van Tonder (The University of Queensland)
Integrable spin-1/2 XY central spin models
05-213 (p. 118)

16:00 Christian Kennedy (The University of Queensland)
6D $\mathcal{N} = (2, 0)$ Conformal Supergravity
05-213 (p. 115)

16:30 Liam Smith (The University of Queensland)
New Deformations of Quantum Field Theories
05-213 (p. 117)

17:00 Ming Chen (The University of Queensland)
Exact solution for Hawking radiation and wave scattering of charged massless scalar field by the charged C-metric black hole
05-213 (p. 114)

. 15 Number Theory

15:00 Kevin Fergusson (Bond University)
Differential Equations Satisfied by Modular Forms
01-E212 (p. 122)

16:00 Nikita Shulga (La Trobe University)
Racidal bound for Zaremba's conjecture
01-E212 (p. 123)

16:30 Mumtaz Hussain (La Trobe University)
Continued fractions and Diophantine approximation
01-E212 (p. 122)

17:00 Aleksander Simonic (University of New South Wales Canberra)
Some conditional estimates for functions in the Selberg class
01-E212 (p. 123)

. 16 Optimisation

13:30 Miguel Goberna (University of Alicante)
Duality and limiting formulas for convex infinite optimization problems
14-116 (p. 125)

14:00 Yingkun (Queenie) Huang (University of New South Wales)
Second-Order Cone Programs for Distributionally Robust Optimisation, with Applications to Revenue Maximisation and Insurance Claims Management
14-116 (p. 126)

14:30 Huyen Duong (University of New South Wales)
Robust Solutions of Single-Leader-Multi-Follower Games
14-116 (p. 125)

15:00 Tan Pham (Federation University Australia)
Minimizing a separable sum coupled by a difference of functions and linear constraints
14-116 (p. 127)

16:00 Yalcin Kaya (University of South Australia)
Infeasible Optimal Control Problems
14-116 (p. 126)

16:30 Daniel Uteda (The University of Melbourne)
Active Support Identification for Finite Max Functions
14-116 (p. 128)

17:00 Thakshila Rajapaksha (University of Wollongong)
Linear convergence of tilt-correct DFO proximal bundle method
14-116 (p. 127)

. 17 Partial Differential Equations

16:00 Jack Thompson (The University of Western Australia)
Some nonlocal geometric identities with applications to classical formulas in Riemannian geometry
08-257 (p. 132)

16:30 Ruixuan Zhu (Australian National University)
Parabolic Monge-Ampère equations without concavity
08-257 (p. 133)

17:00 ABHILASH TUSHIR (None)
DISCRETE HEAT EQUATION WITH IRREGULAR THERMAL CONDUCTIVITY AND TEMPERED DISTRIBUTIONAL DATA
08-257 (p. 132)

. 18 Probability and Mathematical Statistics

13:30 Ross Maller (Australian National University)
Asymptotics of the Allele Frequency Spectrum and the Number of Alleles
03-320 (p. 136)

14:00 Xi Geng (The University of Melbourne)
Expected signature on Riemannian manifolds and its geometric implications
03-320 (p. 134)

14:30 Stephen Muirhead (The University of Melbourne)
Persistence of stationary Gaussian fields with spectral singularity
03-320 (p. 137)

15:00 Andriy Olenko (La Trobe University)
On Fractional Spherically Restricted Hyperbolic Diffusion Random Field
03-320 (p. 137)

16:00 Illia Donhauzer (La Trobe University)
Limit theorems for multifractal products of random fields
03-320 (p. 134)

16:30 Ksenia Sofronova (UNSW Sydney)
Optimal Sequential Decisions with Financial Applications

03-320 (p. 138)

17:00 Joseph Menesch (The University of Queensland)
Automated importance function estimation for adaptive multilevel splitting
03-320 (p. 136)

. 20 Representation Theory

13:30 Yau Wing Li (The University of Melbourne)
Endoscopy for affine Hecke categories
02-D114 (p. 145)

14:00 Dougal Davis (The University of Melbourne)
Unitary representations and localisation for Hodge modules
02-D114 (p. 144)

14:30 Stefano Giannini (The University of Queensland)
Additive character varieties
02-D114 (p. 144)

15:00 Bailey Whitbread (The University of Queensland)
Polynomials in the variable q
02-D114 (p. 146)

16:00 Konstantin Jakob (TU Darmstadt)
Stokes phenomenon of Kloosterman connections
02-D114 (p. 144)

16:30 Dilshan Wijesena (University of New South Wales)
Classifying representations of the Thompson groups and the Cuntz algebra
02-D114 (p. 146)

17:00 Dragan Milicic (None)
A formula for n-homology and its application
02-D114 (p. 145)

. 21 Topology

13:30 Grace Garden (The University of Sydney)
Character varieties and essential surfaces in arbitrary characteristic
01-E215 (p. 149)

14:00 Lecheng Su (Monash University)
Alternating links on non-orientable surfaces
01-E215 (p. 151)

14:30 Alexander He (The University of Queensland)
The triangulation complexity of satellite knots
01-E215 (p. 149)

15:00 James Morgan (The University of Sydney)
On the complexity of two-bridge link complements
01-E215 (p. 151)

16:00 Xavier Coulter (University of Auckland)
A one-parameter deformation of the monotone Hurwitz numbers
01-E215 (p. 149)

16:30 Lukas Anagnostou (The University of Melbourne)
Weil-Petersson volumes, stability conditions and wall-crossing
01-E215 (p. 147)

17:00 Orion Zymaris (Monash University)
Spinors and DescartesŕTheorem
01-E215 (p. 152)

Conference Day 3: Thu 7 December

Summary timetable

When	What
09:00–10:00	**Plenary:** Di Nezza – Ricci-flat spaces: one of the building-blocks of the Universe (p. 70)
10:30–11:30	**Plenary:** Ridout – In which Physics demands new Mathematics (p. 71)
11:30–12:30	**Plenary:** Kumagai – Anomalous random walks and scaling limits: from fractals to random media (p. 71)
12:30–13:30	**Event:** Sponsor presentation 2 (Optiver)
13:30–14:00	16 special session talks
14:00–14:30	17 special session talks
14:30–15:00	17 special session talks
15:00–15:30	14 special session talks
16:00–17:00	**Plenary:** Sharples – Modelling dynamic fire propagation and extreme bushfire development (p. 72)
17:00–18:00	**Event:** AustMS AGM
18:00–21:00	**Event:** Conference Dinner

Non-plenary Sessions

. 2 Applied and Industrial Mathematics

13:30 Yury Stepanyants (University of Southern Queensland)
Lumps and their interactions in the cylindrical Kadomtsev–Petviashvili equation
14-115 (p. 76)

14:00 Murk Bottema (Flinders University)
Integrals of sinc function shifted by integer multiples of pi
14-115 (p. 73)

14:30 Leo Diaz (The University of Melbourne)
Hypergraph representations for systems biology
14-115 (p. 73)

15:00 Luke Bennetts (The University of Adelaide)
Broadband energy capture by an array of heaving buoys
14-115 (p. 73)

. 3 Category Theory, Homotopy Theory, and K-Theory

13:30 Jean-Simon Lemay (Macquarie University)
Hopf Monads on Biproducts
03-262 (p. 81)

14:00 Mircea Voineagu (University of New South Wales)
Bredon motivic cohomology of real numbers
03-262 (p. 82)

14:30 Soichiro Fujii (Macquarie University)
Enrichment preserves fibrations
03-262 (p. 80)

15:00 Michelle Strumila (Monash University)
An overview of infinity modular operads
03-262 (p. 82)

. 5 Computational Mathematics

13:30 Jai Tushar (Monash University)
Optimal Control of Stationary Doubly Diffusive Flows on Two and Three Dimensional Bounded Lipschitz Domains: Numerical Analysis
03-309 (p. 91)

14:00 Ian Turner (QUT)
Multiscale modelling of heterogeneous porous media using implicit evolution equations
03-309 (p. 91)

14:30 Haibo Li (The University of Melbourne)
A preconditioned Krylov subspace method for linear inverse problems with general-form Tikhonov regularization
03-309 (p. 88)

15:00 Hailong Guo (The University of Melbourne)
Discontinuous Galerkin methods for the Laplace-Beltrami operator on point cloud
03-309 (p. 85)

. 6 Dynamical Systems and Ergodic Theory

13:30 Andy Hammerlindl (Monash University)
Partial Hyperbolicity on Seifert manifolds
35-519 (p. 93)

14:00 Gerardo González Robert (La Trobe University)
Dynamical aspects of complex continued fractions
35-519 (p. 93)

14:30 Renaud Leplaideur (Université de la Nouvelle Calédonie)
Selection in ergodic Optimization
35-519 (p. 94)

15:00 Sean Gasiorek (California Polytechnic State University)
Dynamics and Periodicity Conditions for the Integrable Boltzmann System
35-519 (p. 93)

. 7 Equity, Diversity and Inclusion in Mathematics

13:30 Marcy Robertson (The University of Melbourne)
What if Sherman Alexie were a mathematician ?
67-442 (p. 97)

14:00 Rowena Ball (The Australian National University)
Equity and diversity OF mathematics
67-442 (p. 95)

14:30 Benjamin Burton (The University of Queensland)
Diversity in academic competitions: Success, failures, and works in progress
67-442 (p. 96)

15:00 Leah South (Queensland University of Technology)
A plan for reducing sexual assault and sexual harassment
67-442 (p. 97)

. 9 Geometric Analysis

13:30 Rod Gover (University of Auckland)
Conformal aspects of submanifolds and curves
08-212 (p. 100)

14:00 ()
08-212 (p. **??**)

14:30 James McCoy (The University of Newcastle)
Higher order linear curvature flow
08-212 (p. 101)

15:00 Glen Edward Wheeler (University of Wollongong)
Using an ODE to prove the parametrised isoperimetric inequality
08-212 (p. 102)

. 10 Algebra and Combinatorics

14:00 Kerri Morgan (Royal Melbourne Institute of Technology)
Certificates of Splitting Field Equivalence for the Chromatic Polynomial
01-E302 (p. 105)

14:30 Marcel Jackson (La Trobe University)
Some finite model theoretic considerations in algebra
01-E302 (p. 104)

15:00 Sunil Chebolu (Illinois State University)
The Resonance Hyperplane Arrangement
01-E302 (p. 103)

. 12 Modern Techniques in Financial Mathematics

13:30 Ivan Guo (Monash University)
An Efficient Frontier of Wealth Distributions with Connections to Utility Maximisation
03-314 (p. 111)

14:00 Yuyu Chen (The University of Melbourne)
An unexpected stochastic dominance: Pareto distributions, catastrophes, and risk exchange
03-314 (p. 110)

14:30 Tomonori Nakatsu (Shibaura Institute of Technology)
Computation of the Greeks of barrier options
03-314 (p. 112)

15:00 Kaustav Das (Monash University)
On Stochastic Partial Differential Equations and their applications to Derivative Pricing through a conditional Feynman-Kac formula
03-314 (p. 111)

. 13 Mathematical Physics

13:30 Nalini Joshi (The University of Sydney)
Birational maps through the lens of cryptography
05-213 (p. 115)

14:00 Harini Desiraju (The University of Sydney)
Modular transformation of the toric conformal blocks
05-213 (p. 114)

14:30 Thao Thuan Vu Ho (Monash University)
Hamiltonian approach to 2-layer density stratified fluids.
05-213 (p. 118)

15:00 Ian Marquette (The University of Queensland)
Polynomial algebras from Lie algebra reduction chains $\mathfrak{g} \supset \mathfrak{g}'$
05-213 (p. 116)

. 14 Mathematics Education

13:30 Paul Fijn (The University of Melbourne)
Rethinking Statistics Computer Lab Classes
69-401 (p. 119)

14:00 Leesa Sidhu (University of New South Wales Canberra)
Supporting Students AND Tutors in the Maths and Stats Classroom
69-401 (p. 120)

14:30 Matthew Paul Skerritt (RMIT University)
Divergent Assessment in Undergraduate Mathematics

69-401 (p. 120)

. 15 Number Theory

13:30 Adrian Dudek (The University of Queensland)
Prime Numbers in Short Intervals on RH
01-E212 (p. 122)

14:00 Timothy Trudgian (UNSW Canberra)
Defrosting Ingham's frozen theorem for zeta
01-E212 (p. 123)

14:30 Bryce Kerr (UNSW Canberra)
Coppersmith's method in many variables
01-E212 (p. 122)

. 16 Optimisation

13:30 Nadia Sukhorukova (Swinburne University of Technology)
Deep learning and its mathematical nature
14-116 (p. 128)

14:00 ()
14-116 (p. **??**)

14:30 Fred Roosta (The University of Queensland)
A Newton-MR Algorithm With Complexity Guarantees for Nonconvex Optimization
14-116 (p. 128)

15:00 Vinesha Peiris (Curtin University)
A comparison of rational and neural network based approximations
14-116 (p. 127)

. 17 Partial Differential Equations

13:30 Daniel Hauer (The University of Sydney)
An extension problem for the logarithmic Laplacian
08-257 (p. 130)

14:00 Kwok-Kun Kwong (University of Wollongong)
Inverse curvature flow and two families of weighted geometric inequalities involving three quantities
08-257 (p. 131)

14:30 Jesse Gell-Redman (None)
New perspectives in scattering for nonlinear evolution equations
08-257 (p. 130)

15:00 Rong Wang (The Australian National University)
Long-time dynamics of an diffusive epidemic model with free boundaries
08-257 (p. 132)

. 18 Probability and Mathematical Statistics

13:30 Peter Gerrard Taylor (The University of Melbourne)
A General Framework for Modelling Hypnozoite Accrual and Superinfection in Malaria
03-320 (p. 138)

14:00 Aihua Xia (The University of Melbourne)
On the rate of normal approximation for Poisson continuum percolation
03-320 (p. 139)

14:30 Kihun Nam (Monash University)
Coupled FBSDEs with Measurable Coefficients and its Application to Parabolic PDEs
03-320 (p. 137)

15:00 ()
03-320 (p. **??**)

. 19 Stochastic Differential Equations

13:30 Erika Hausenblas (Montanuniversitaet Leoben)
A stochastic bidomain model with Gaussian and pure Lévy noise
03-315 (p. 140)

14:00 Beniamin Goldys (The University of Sydney)
Erika Hausenblas: A stochastic bidomain model with Gaussian and pure Levy noise, part II
03-315 (p. 140)

14:30 Ruyi Liu (The University of Sydney)
Pairs Trading: An Optimal Selling Rule with Constraints
03-315 (p. 142)

. 20 Representation Theory

13:30 Jieru Zhu (None)
M-diagram bases of the Specht module for three row partitions
02-D114 (p. 147)

14:00 Justine Fasquel (The University of Melbourne)
Building blocks for W-algebras
02-D114 (p. 144)

14:30 Ian Le (Australian National University)
Cluster Structures on Braid Varieties
02-D114 (p. 144)

15:00 Geordie Williamson (None)
4-Strand Burau is Unfaithful Modulo 5
02-D114 (p. 146)

. 21 Topology

13:30 Agnese Barbensi (The University of Queensland)
Topological Optimal Transport and Geometric Cycle Matchings
01-E215 (p. 147)

14:00 Yossi Bokor Bleile (Aalborg University)
Topology, geometry and microstructures
01-E215 (p. 148)

14:30 Marcy Robertson (The University of Melbourne)
Towers of Kashiwara-Vergne Solutions
01-E215 (p. 151)

15:00 Finnur Larusson (The University of Adelaide)
Homotopy theory in the theory of minimal surfaces
01-E215 (p. 150)

Conference Day 4: Fri 8 December

Summary timetable

When	What
09:00–10:00	**Plenary:** Robertson – Proped up homotopy theory (p. 72)
10:30–11:30	**Plenary:** Wei – Fundamental Gap of Convex Domains in Space Forms and Surfaces (p. 72)
11:30–12:30	**Plenary:** Wright – Optimization in Theory and Practice (p. 73)
13:30–14:00	11 special session talks
14:00–14:30	12 special session talks
14:30–15:00	12 special session talks
15:00–15:30	11 special session talks
16:00–16:30	7 special session talks
16:30–17:00	7 special session talks
17:00–17:30	3 special session talks
17:30–18:00	Special session talk

Non-plenary Sessions

. 2 Applied and Industrial Mathematics

13:30 Dietmar Oelz (The University of Queensland)
A mechanochemical model for symmetry breaking in Hydra spheroids
14-115 (p. 76)

14:00 Timothy McDevitt (Elizabethtown College)
Impossible Pair Attacks Against Nonlinear Combiners
14-115 (p. 75)

14:30 Simon Watt (UNSW Canberra)
Chaotic flow in competitive exothermic-endothermic reaction systems
14-115 (p. 77)

. 5 Computational Mathematics

13:30 Xin Guo (The University of Queensland)
Capacity dependent analysis for functional online learning algorithms
03-309 (p. 86)

14:00 Sergio Rojas (Pontificia Universidad Católica de Valparaíso)
Local minimum-residual a posteriori error estimates for a class of mixed finite element discretizations
03-309 (p. 89)

14:30 Ricardo Ruiz Baier (Monash University)
Twofold saddle-point formulations for stress-altered diffusion models
03-309 (p. 90)

15:00 Bishnu Lamichhane (The University of Newcastle)
A mixed finite element method for fourth and sixth-order partial differential equations
03-309 (p. 87)

16:00 Rekha Mallappa Khot (Monash University)
Conforming virtual element method for forward and inverse source problems with rough data
03-309 (p. 87)

16:30 Ashvni Narayanan (The University of Sydney)
A tool for autoformalization of mathematics in Lean
03-309 (p. 89)

17:00 Quoc Thong Le Gia (University of New South Wales)
Quasi-Monte Carlo sparse grid Galerkin FEMs for linear elasticity equations with uncertainties
03-309 (p. 87)

17:30 ()
03-309 (p. **??**)

. 6 Dynamical Systems and Ergodic Theory

13:30 Martin Wechselberger (The University of Sydney)
(Hidden) multiple timescales and the parametrisation method in geometric singular perturbation theory
67-442 (p. 95)

14:00 John Roberts (University of New South Wales)
Rotations of the circle and their symbolic dynamics
67-442 (p. 94)

14:30 Warwick Tucker (Monash University)
The Songling system has exactly four limit cycles
67-442 (p. 95)

. 8 Functional Analysis

15:00 Vyacheslav Abramov (N/A)
Fixed point theorem for an infinite Toeplitz matrix and its extension to general infinite matrices
67-442 (p. 97)

16:00 Aidan Sims (University of Wollongong)
Reconstruction of Lie groupoids from spectral data
67-442 (p. 98)

16:30 Thomas Scheckter (UNSW Sydney)
Noncommutative L^p Spaces are Primary
67-442 (p. 98)

. 9 Geometric Analysis

13:30 Min-Chun Hong (The University of Queensland)
On Chen's conjecture for biharmonic hypersurfaces
08-212 (p. 100)

14:00 Giorgio Poggesi (The University of Western Australia)
Soap bubbles and convex cones
08-212 (p. 101)

14:30 Brian Krummel (The University of Melbourne)
Analysis of singularities of area minimizing currents
08-212 (p. 100)

15:00 Pak Tung Ho (Tamkang University)
Results related to prescribing Gaussian curvature and geodesic curvature
08-212 (p. 100)

. 10 Algebra and Combinatorics

14:00 Marcia Ricci Pinheiro (None)
Equal Probability for the Monty Hall Problemś Options
01-E302 (p. 106)

14:30 Sean Lynch (UNSW Sydney)
Generating functions in algebra, combinatorics and algebraic geometry
01-E302 (p. 105)

15:00 Paul Charles Leopardi (Australian National University)
Relations between equivalences of bent functions
01-E302 (p. 104)

. 11 Harmonic Analysis

13:30 Adam Sikora (Macquarie University)
Hardy spaces meet harmonic weights revisited
08-257 (p. 109)

14:00 Bingyang Hu (None)
On the curved trilinear Hilbert transform
08-257 (p. 108)

14:30 Daniel Hauer (The University of Sydney)
Bernstein functional calculus and a generalized Helmholtz problem
08-257 (p. 108)

. 12 Modern Techniques in Financial Mathematics

14:30 Haejun Jeon (Tokyo University of Science)
Time-to-build, regulation, and investment
03-314 (p. 111)

15:00 Duy-Minh Dang (The University of Queensland)
Fourier Neural Network Approximation of Transition Densities in Finance
03-314 (p. 110)

. 13 Mathematical Physics

13:30 Jean-Emile Bourgine (The University of Melbourne)
A (q,t)-deformation of the Toda integrable hierarchy
05-213 (p. 113)

14:00 Alexander Sherman (The University of Sydney)
Queer Kac-Moody algebras and an so(3) superconformal algebra
05-213 (p. 117)

14:30 Yang Zhang (The University of Queensland)
Einstein metrics on homogeneous superspaces
05-213 (p. 118)

15:00 Jon Links (The University of Queensland)
An unsolvable case of Yang-Baxter integrability
05-213 (p. 116)

. 16 Optimisation

13:30 Hong-Kun Xu (Hangzhou Dianzi University)
Extra-anchored Halpern Iteration and Applications in Variational Inequalities
14-116 (p. 129)

14:00 ()
14-116 (p. **??**)

14:30 Thi Hoa Bui (Curtin University)
Cutting Plane Algorithms are Exact for Euclidean Max-Sum Problems
14-116 (p. 124)

15:00 Reinier Diaz Millan (Deakin University)
Extragradient method with feasible inexact projection to variational inequality problem
14-116 (p. 125)

16:00 ()
14-116 (p. **??**)

16:30 ()
14-116 (p. **??**)

. 17 Partial Differential Equations

15:00 Artem Pulemotov (The University of Queensland)
Hermitian metrics with vanishing second Chern Ricci curvature
08-257 (p. 132)

16:00 Glen Edward Wheeler (University of Wollongong)
The Entropy Flow
08-257 (p. 133)

16:30 Yihong Du (University of New England)
Rate of acceleration in propagation of the KPP equation with nonlocal diffusion and free boundaries
08-257 (p. 130)

. 18 Probability and Mathematical Statistics

13:30 Geoffrey McLachlan (The University of Queensland)
A Surprising Result in Semi-Supervised Learning
03-320 (p. 136)

14:00 Jesse Goodman (University of Auckland)
Splitting the saddlepoint approximation across a sample path
03-320 (p. 135)

14:30 Pavel Krupskiy (The University of Melbourne)
Max-convolution processes with random shape indicator kernels
03-320 (p. 135)

15:00 Alysha De Livera (La Trobe University)
Multivariate meta-analysis methods for high-dimensional data
03-320 (p. 133)

16:00 David James Warne (Queensland University of Technology)
Multidelity multilevel Monte Carlo for approximate Bayesian computation
03-320 (p. 138)

16:30 Renjie Feng (The University of Sydney)
A graphical formula for cumulants of multivariate linear statistics of determinantal point processes.
03-320 (p. 134)

17:00 Kazutoshi Yamazaki (The University of Queensland)
Lévy bandits under Poissonian decision times
03-320 (p. 139)

. 19 Stochastic Differential Equations

13:30 Quoc Thong Le Gia (University of New South Wales)
Discretisation of a class of semilinear stochastic PDEs on the unit sphere and invariant measures
03-315 (p. 142)

14:00 Jie Yen Fan (Monash University)
Measure-valued processes and stochastic partial differential equations
03-315 (p. 140)

16:00 Debopriya Mukherjee (Indian Institute of Technology Indore)
A shape Calculus Approach for time harmonic solid - fluid interaction problem in stochastic domains
03-315 (p. 142)

16:30 Ngan Le (Monash University)
Stochastic perturbation vs variance of solutions to stochastic PDEs
03-315 (p. 141)

. 20 Representation Theory

13:30 ()
02-D114 (p. **??**)

14:00 Peter McNamara (The University of Melbourne)
The Spin Brauer Category
02-D114 (p. 145)

14:30 Travis Scrimshaw (Hokkaido University)
Representations of twisted quantum Clifford algebras
02-D114 (p. 146)

15:00 ()
02-D114 (p. **??**)

. 21 Topology

13:30 Marcos Orseli (The University of Adelaide)
Equivariant index on toric contact manifolds
01-E215 (p. 151)

14:00 Rod Gover (University of Auckland)
Some progress on the ASD deformation complex
01-E215 (p. 149)

14:30 Stephan Tillmann (The University of Sydney)
Slope norm, crosscap number and complexity of Dehn fillings
01-E215 (p. 152)

15:00 Joshua Howie (Monash University)
Free spanning surfaces which are not isotopic to state surfaces
01-E215 (p. 149)

16:00 Daniele Celoria (The University of Melbourne)
A q-hypergeometric approach to the 3D index
01-E215 (p. 148)

16:30 Benjamin Burton (The University of Queensland)
Parallelism in topological algorithms
01-E215 (p. 148)

Abstracts

1. Plenary

Bartlett, Peter. Benign Overfitting
Speaker: Peter Bartlett (UC Berkeley)
Time: 11:30 Wed 6 December
Place(s): 23-101
Author(s): Peter Bartlett

Deep learning has revealed some major surprises from the perspective of statistical complexity: even without any explicit effort to control model complexity, these methods find prediction rules that give a near-perfect fit to noisy training data and yet exhibit excellent prediction performance in practice. This talk reviews recent work on methods that predict accurately in probabilistic settings despite fitting too well to training data. We see how benign overfitting can occur with sufficient overparameterization in regression and classification problems, but it leads to sensitivity to adversarial examples.

De Lellis, Camillo. Area-minimizing integral currents: singularities and structure
Speaker: Camillo De Lellis (Institute for Advanced Study)
Time: 17:30 Tue 5 December
Place(s): 49-200
Author(s): Camillo De Lellis, Paul Minter, Anna Skorobogatova

Area-minimizing integral currents were introduced by De Giorgi, Federer, and Fleming to build a successfull existence theory for the *oriented* Plateau problem. While celebrated examples of singular minimizers were discovered soon after, a first theorem which summarizes the work of several mathematicians in the 60es and 70es (De Giorgi, Fleming, Almgren, Simons, and Federer) and a second theorem of Almgren from 1980 give general dimension bounds for the singular set which match the one of the examples, in codimension 1 and in general codimension respectively.
In joint works with Anna Skorobogatova and Paul Minter we prove that in higher codimension the singular set is $(m-2)$-rectifiable and the tangent cone is unique at $\mathcal{H}^{m-2}$-a.e. point. Independently and at the same time, a proof of the same result has been discovered also by Krummel and Wickramasekera. This theorem is the counterpart, in general codimension, of a celebrated work of Leon Simon in the nineties for the codimension 1 case. Moreover, a recent theorem by Liu proves that the singular set can in fact be a fractal of any Hausdorff dimension $\alpha \leq m-2$, indicating that the above structure theorem is indeed close to optimal.

Di Nezza, Eleonora. Ricci-flat spaces: one of the building-blocks of the Universe
Speaker: Eleonora Di Nezza (Sorbonne Université)
Time: 09:00 Thu 7 December
Place(s): 23-101
Author(s): Tamás Darvas, Eleonora Di Nezza, Chinh Lu

Motivated by theoretical physics and algebraic geometry, we search for special metrics on a Kähler manifolds. Examples of these are Ricci flat metrics. The geometric problem of the existence of these metrics can be reformulated in terms of analytic one: solving a Monge-Ampère equation. In this talk I will give a panorama of what it is known and what the recent developments are.

Dullin, Holger. On the Stability of the 3-Body Problem
Speaker: Holger Dullin (The University of Sydney)
Time: 09:00 Wed 6 December
Place(s): 23-101
Author(s): Holger Dullin

At the ICM in Berlin in 1998, Michael Herman formulated what he called the "oldest problem in dynamics": Is the set of unbounded orbits in the 3-body problem dense for negative energies? I will explain the background of this question, and present recent results obtained jointly with Albouy and Scheurle that show that the answer to this question is in the negative. The catch is that our results hold for the 3-body problem in 4-dimensional space, but do not transfer to the usual setting in 2- or 3-dimensional space. We show that for 3 bodies in dimension 4 there are periodic solutions that are Lyapunov stable relative equilibria in the symmetry reduced system. I will explain this result, and along the way will describe some of the beautiful mathematics that originated in explorations of the 3-body problem.

Hillock, Poh. Transforming First Year Mathematics: opening doors to success
Speaker: Poh Hillock (The University of Queensland)
Time: 17:30 Wed 6 December
Place(s): 23-101
Author(s): Poh Hillock

First year mathematics should open doors. All too often however, it becomes a barrier to a student's successful participation in their degree. In this presentation, I will describe how the School of Mathematics and Physics at The University of Queensland has helped first year mathematics students open those doors by implementing a wide support network and through course transformation. The support network leverages high impact practices such as differentiated and collaborative learning. A key element of the support network is the Support Learning Tutorial which recognises students as individuals, with specific learning needs. Despite the increased support, engagement in first year mathematics continued to be low with less than half of the cohort attending lectures and tutorials. In 2018, we addressed the issues of low engagement by redesigning our largest first year maths course (annual enrolment 2000) to deliver greater flexibility and high value on-campus engagement. The redesign was highly successful, evidenced by course evaluation data, student and tutor feedback, and led to the subsequent redevelopment of several other large first year mathematics courses and a large second year course. Note: the presentation is an expanded version of my talk at the CETL-MSOR (Centre for Excellence in Teaching and Learning in Mathematics, Statistics, and Operational Research) conference in Cardiff, Wales, 7 - 8 September 2023.

Kumagai, Takashi. Anomalous random walks and scaling limits: from fractals to random media
Speaker: Takashi Kumagai (Waseda University)
Time: 11:30 Thu 7 December
Place(s): 23-101
Author(s): Takashi Kumagai

We present results on the behavior of random walks and scaling limits on disordered media. Examples treated include fractals and models of random graphs, such as percolation clusters, uniform spanning trees and random planar maps. We will overview the areas chronologically, and describe how the techniques have developed from those introduced for self-similar fractals to more robust ones required for random graphs.

Peluse, Sarah. Arithmetic patterns in dense sets
Speaker: Sarah Peluse (University of Michigan)
Time: 11:30 Tue 5 December
Place(s): 49-200
Author(s): Sarah Peluse

Some of the most important problems in combinatorial number theory ask for the size of the largest subset of the integers in an interval lacking points in a fixed arithmetically defined pattern. One example of such a problem is to prove the best possible bounds in Szemerédi's theorem on arithmetic progressions, i.e., to determine the size of the largest subset of $\{1, ..., N\}$ with no nontrivial k-term arithmetic progression $x, x + y, ..., x + (k - 1)y$. Gowers initiated the study of higher order Fourier analysis while seeking to answer this question, and used it to give the first reasonable upper bounds for arbitrary k. In this talk, I'll discuss recent progress on quantitative polynomial, multidimensional, and nonabelian variants of Szemerédi's theorem and on related problems in number theory, harmonic analysis, and ergodic theory.

Ridout, David. In which Physics demands new Mathematics
Speaker: David Ridout (The University of Melbourne)
Time: 10:30 Thu 7 December
Place(s): 23-101
Author(s): David Ridout

Two-dimensional conformal field theory is a physical notion, known mathematically for being the main source of vertex operator algebras (VOAs). One of the best understood examples are the affine VOAs, constructed as representations of an untwisted affine Kac–Moody algebra associated to a simple complex Lie algebra $\mathfrak{g}$. This sounds complicated, and perhaps it is, but a decent fraction of the representation theory of an affine VOA may be traced back to that of $\mathfrak{g}$.
This is where things start to get hard...

You see, Physics places demands on affine VOAs, some of which can be expressed through the representation theory of $\mathfrak{g}$. Sometimes, these demands can be met with classical knowledge. Recently however, the demands have increased and much more sophisticated results are needed. But, Physics always seems to want more. I will try to explain this using examples with $\mathfrak{g} = \mathfrak{sl}_2$ and $\mathfrak{sl}_3$, the goal being to see why Physics is now demanding that we consider scary (ie, interesting) new Mathematics, even for something as simple as $\mathfrak{sl}_3$.

Robertson, Marcy. Proped up homotopy theory
Speaker: Marcy Robertson (The University of Melbourne)
Time: 09:00 Fri 8 December
Place(s): 23-101
Author(s): Marcy Robertson

Traditionally, algebraic topology concerned itself with the classification of topological objects up to a type of continuous deformation called "homotopy." A revolution was born when Quillen came along and showed us that we could formalize and export the notion of what it means to be "homotopic" into other areas of mathematics. Now, we see homotopical constructions in areas ranging from algebraic geometry and representation theory to computer science to quantum field theories.
In my talk, I'll introduce these homotopical ideas through my own long-term battle with mathematical objects called ∞-props. To motivate the discussion, I'll start with the problem of quantizing Lie bialgebras and, after adding in our homotopy theory, end up at a new problem in knot theory.
This talk is aimed at a general audience. No previous knowledge of quanitzation or homotopy theory is expected.

Roney-Dougal, Colva. Counting groups
Speaker: Colva Roney-Dougal (University of St Andrews)
Time: 10:30 Wed 6 December
Place(s): 23-101
Author(s): Colva Roney-Dougal

What does a random group look like? This talk will start with a brief survey of how we might go about counting groups. We'll then go on to see what a random group might be, in various different contexts.
Every group arises as a subgroup of a symmetric group. An elementary argument shows that there are at least $2^{n^2/16}$ subgroups of the symmetric group on n points, and it was conjectured by Pyber in 1993 that up to lower order error terms this is also an upper bound. This talk will present an answer to Pyber's conjecture, and some consequences for random subgroups of the finite symmetric groups. The new results in this talk are joint work with Gareth Tracey (Warwick).

Sharples, Jason. Modelling dynamic fire propagation and extreme bushfire development
Speaker: Jason Sharples (University of New South Wales)
Time: 16:00 Thu 7 December
Place(s): 23-101
Author(s): Jason Sharples

Bushfires are a worsening environmental problem. They can have significant socioeconomic and ecological ramifications and can negatively affect Earth systems at regional and global scales. Of particular concern are large bushfires that burn under extreme conditions, and which exhibit dynamic behaviours that are not well accounted for by traditional bushfire risk management systems. In this talk, I will provide an overview of some of the more pressing challenges encountered in the mathematical modelling of bushfires and highlight some of the work that has been done (and is being done) towards addressing these challenges.

Wei, Guofang. Fundamental Gap of Convex Domains in Space Forms and Surfaces
Speaker: Guofang Wei (University of California, Santa Barbara)
Time: 10:30 Fri 8 December
Place(s): 23-101
Author(s): Guofang Wei

The fundamental gap refers to the difference between the first two eigenvalues of the Laplacian or more generally for Schrödinger operators. It is a very important quantity both in mathematics and physics as the eigenvalues are possible allowed energy values in quantum physics. We will review many recent fantastic results for convex domains in $\mathbb{R}^n, \mathbb{S}^n, \mathbb{H}^n$ with Dirichlet boundary conditions, starting

with the breakthrough of Andrews-Clutterbuck. Then we will present a very recent estimate for the convex domain in surfaces with positive curvature. The last result is joint with G. Khan, H. Nguyen, M. Tuerkoen.

Wright, Stephen. Optimization in Theory and Practice
Speaker: Stephen Wright (University of Wisconsin-Madison)
Time: 11:30 Fri 8 December
Place(s): 23-101
Author(s): Stephen Wright

Complexity analysis in optimization seeks upper bounds on the amount of work required to find approximate solutions of optimization problems in a given class with a given algorithm. There is also study of lower bounds, usually in the form of a worst-case example from a given problem class for a given algorithm class. The relationship between theoretical complexity bounds and practical performance of algorithms on "typical" problems varies widely across problem and algorithm classes, and relative interest among researchers between the theoretical and practical aspects of algorithm design and analysis has waxed and waned over the years. This talk surveys complexity analysis and its relationship to practice in optimization, with an emphasis on linear programming and convex and nonconvex nonlinear optimization, providing historical (and cultural) perspectives on research in these areas.

2. Applied and Industrial Mathematics

Bennetts, Luke. Broadband energy capture by an array of heaving buoys
Speaker: Luke Bennetts (The University of Adelaide)
Time: 15:00 Thu 7 December
Place(s): 14-115
Author(s): Amy-Rose Westcott; Nataliia Sergienko; Ben Cazzolato; Luke Bennetts

Broadband energy capture is sought by grading the resonant properties of an array of heaving buoy-type wave energy converters (WECs) in 2D. Linear potential-flow theory is applied and WEC interactions are modelled using multiple-wave scattering theory. The resonant properties of WECs are tuned via a linear spring-damper power take-off mechanism to manipulate the complex-frequency zeros. The resulting graded array captures near-perfect absorption (¿97

Bottema, Murk. Integrals of sinc function shifted by integer multiples of pi
Speaker: Murk Bottema (Flinders University)
Time: 14:00 Thu 7 December
Place(s): 14-115
Author(s): Anthony Marshall, Simon Williams, Murk J Bottema

Sinc functions ($\psi(x) = \sin x/x$) pop up in a plethora of circumstances. Much is known about them. In particular, integrals of combinations of sinc function appear in tables but seldom the ones needed in the heat of the moment. This was the dilemma of the authors and so, to add to the glut of such formulae, we consider integrals of products of sinc functions shifted by integer multiples of π and derivatives of such function. A method is described for obtaining closed-form solutions for any integral of this form, just in case you come across one of these. Only calculus is needed.

Diaz, Leo. Hypergraph representations for systems biology
Speaker: Leo Diaz (The University of Melbourne)
Time: 14:30 Thu 7 December
Place(s): 14-115
Author(s): Léo Diaz, Sean Vittadello, Michael Stumpf

Systems biology represents the effort to understand the behaviour of systems of interacting biological elements. Key challenges in understanding these systems are their complexity and heterogeneity: elements of interest often exist across scales and nature, and interact with each other through intricate patterns. As a result, developing mathematical models suitable for describing these systems is an open question. Here we show precisely how two current graph-based modelling formalisms used in systems biology and beyond—chemical reaction networks and stochastic Petri nets—can be represented exactly as hypergraphs, i.e. as pairs (V, E) of vertices V and hyperedges E, with $E \subseteq \wp(V)$ where $\wp(V)$ is the power set of V. Beyond naturally relaxing the limitations imposed by graphs, the generality and

the flexibility of the hypergraph framework has two key advantages: 1) it affords clarity and allows us to better understand our modelling formalisms; and 2) it makes models readily amenable to more formal mathematical analysis than is usually afforded in biological contexts. Such formalisation has the potential to help address the challenges of understanding complex dynamical systems through the use of more powerful mathematical tools.

Ding, Yining. Pricing and Hedging of Cross-Currency Basis Swaps Referencing Backward-Looking Rates
Speaker: Yining Ding (The University of Sydney)
Time: 16:30 Wed 6 December
Place(s): 14-115
Author(s): Yining Ding, Ruyi Liu and Marek Rutkowski

The financial industry has undergone a significant transition from the London Interbank Offered Rate (LIBOR) to Risk Free Rates such as, e.g., the Secured Overnight Financing Rate (SOFR) in the U.S. and Australian Overnight Index Average (AONIA) in the AU, as the primary benchmark for borrowing costs. The paper examines the arbitrage-free pricing and hedging method for SOFR-related financial products in a cross-currency context with the special emphasis on the SOFR vs AONIA cross-currency basis swaps (CCBS). While the AONIA rate serves as a specific example, the approach developed is able to handle backward-looking rates for any two currencies. We give explicit pricing and hedging results for collateralized CCBS using futures contracts as hedging tools under Vasicek's model.

Flegg, Mark. Modelling of a Tomato Glasshouse
Speaker: Mark Flegg (Monash University)
Time: 16:00 Tue 5 December
Place(s): 14-115
Author(s): Mark Flegg

In this talk I will report on work that was undertaken at the Mathematics in Industry Study Group (MISG) in February 2023. I will focus on mathematical modelling performed for the Costa Group of their 40 hectare tomato glasshouse facility in Guyra, NSW. The MISG is a major annual event in Australian industrial applied mathematics. At the end of the talk I will give a quick summary of the other projects that were worked on this year with the aim of presenting the ethos and diversity of the event for those who are unfamiliar with it.

Ham, Lucy. Deterministic hares, and stochastic tortoises: the timing of cellular events
Speaker: Lucy Ham (The University of Melbourne)
Time: 15:00 Wed 6 December
Place(s): 14-115
Author(s): Lucy Ham

Changes in cell state are driven by molecular processes; many of which are initiated when molecule numbers reach and exceed specific thresholds, a characteristic that can be described as "digital cellular logic". While the time to cross a critical threshold – the first-passage time – can be estimated by deterministic models, these ignore intrinsic molecular and cellular noise, and hence may lead to biased predictions. In this talk, we show how noise profoundly influences the first-passage time, and map out parameter regimes in which stochastic dynamics result in shorter or longer average first-passage times compared to noise-less dynamics. We illustrate the dependence of the mean first-passage time on noise for a set of exemplar Markov models of gene expression, auto-regulatory feedback control, and enzyme-mediated catalysis. Our results provide intuitive insight into the origin of these effects and underscore two important insights: (i) deterministic models for cellular event timing can be highly inaccurate when molecule numbers are within the range known for many cells; (ii) molecular noise can significantly alter mean first-passage times, particularly within feedback circuits.

Holden, Matthew. Quantifying the value of data and models for environmental management
Speaker: Matthew Holden (The University of Queensland)
Time: 13:30 Tue 5 December
Place(s): 14-115
Author(s): Matthew Holden, Vincent Cattoni

Applied mathematicians often argue that models are crucial for making good decisions that balance environmental and economic objectives. Yet how do we know models ăctuallyïmprove outcomes for nature? In this talk, I will describe two examples, in fisheries and threatened species management, and explain why the most popular mathematical models/frameworks might lead to decisions that are

unfavourable for nature conservation and also may lead to decreased research budgets. I will argue for a more precautionary approach to maths and modelling for conservation and natural resource management.

Kardkasem, Ruethaichanok. Extreme Precipitation on the Eastern Coast of Australia
Speaker: Ruethaichanok Kardkasem (The University of Queensland)
Time: 16:30 Tue 5 December
Place(s): 14-115
Author(s): Ruethaichanok Kardkasem

Severe flooding is an ongoing problem along the eastern coast of Australia, mainly attributable to multi-day extreme precipitation. Climate change has been identified as a significant contributor to these extreme weather events. However, conventional methods of estimating return levels using extreme value theory may not account for the impacts of non-stationary climate conditions. Moreover, these methods do not account for consecutive daily precipitation extremes. Our research aims to address these limitations by developing a comprehensive approach to extreme value analysis incorporating spatial-temporal and climate change variables, mainly focusing on consecutive extreme precipitation events.

Lefevre, James. Optimal control of Multiple Myeloma assuming drug evasion and off-target effects
Speaker: James Lefevre (The University of Queensland)
Time: 14:00 Wed 6 December
Place(s): 14-115
Author(s): James G. Lefevre, Brodie Lawson, Pamela Burrage, Diane Donovan, Kevin Burrage

Multiple Myeloma (MM) is a plasma cell cancer that occurs in the bone marrow. A leading treatment for MM is the monoclonal antibody Daratumumab, targeting the CD38 receptor, which is highly overexpressed in myeloma cells. In this work we model drug evasion via loss of CD38 expression, which is a proposed mechanism of resistance to Daratumumab treatment. We develop an ODE model which includes drug evasion via two mechanisms: a direct effect in which CD38 expression is lost without cell death in response to Daratumumab, and an indirect effect in which CD38 expression stochastically switches on and off in the cancer cells; CD38- myeloma cells have lower fitness but are shielded from the drug action. The model also incorporates competition with healthy cells, death of healthy cells due to off-target drug effects, and a Michaelis-Menten type immune response. Using optimal control theory, we study the effect of the drug evasion mechanisms and the off-target drug effect on the optimal treatment regime. We identify a general increase in treatment duration and costs, with varying patterns of response for the different controlling parameters. Several distinct optimal treatment regimes are identified within the parameter space.

Mackellar, Jason. Towards an algorithm for the de-convolution of fractionation data
Speaker: Jason Mackellar (The University of Newcastle)
Time: 17:00 Tue 5 December
Place(s): 14-115
Author(s): Jason Mackellar,

The need for size and density distributions in the mineral processing industry is a significant factor for reducing costs in mineral processing. It is also for effective design and development of gravity separation technologies. Existing methods to generate these distributions such as sink-float are problematic and have severe limitations. Previous studies have shown that the REFLUXTM Classifier can be used as an effective method to generate size and density distributions. A mathematical model to reflect the actions of the REFLUXTM Classifier is needed to better understand the factors that come into play and help predict the outcome in experiments for size and density properties for particles.

McDevitt, Timothy. Impossible Pair Attacks Against Nonlinear Combiners
Speaker: Timothy McDevitt (Elizabethtown College)
Time: 14:00 Fri 8 December
Place(s): 14-115
Author(s): Timothy McDevitt

Stream ciphers are symmetric key cryptosystems that have been used for decades for their speed and simplicity of implementation, and they are very useful in situations where the data to be encrypted can have a variable size. One important class of stream ciphers uses several shift registers and a nonlinear Boolean combining function f to produce a pseudorandom keystream of bits that is added (modulo 2)

to plaintext to produce ciphertext. In 1985, Siegenthaler famously introduced a divide-and-conquer correlation attack against nonlinear combiners that uses a function q that approximates f but has a smaller support, thereby allowing the cryptanalyst to solve several smaller problems instead of one large, intractable problem. It is well known that q should be linear to provide maximal statistical power. However, nonlinear q functions can actually reduce the amount of data required for an attack by taking a different approach, namely choosing q to produce values of (f, q) that are impossible when the putative register fills are incorrect. Interestingly, the impossible pair attack achieves 100% statistical power. This talk discusses the impossible pair attack and compares it to the standard correlation attack.

Ngwu, Benitho Amaobi. Geometric Singular Perturbation Approach to GlassŃetworks
Speaker: Benitho Amaobi Ngwu (Federal University Oye Ekiti)
Time: 14:30 Wed 6 December
Place(s): 14-115
Author(s): Benitho Amaobi Ngwu, Godwin C.E. Mbah and Isienyi Sunday U

Glass network is a class of gene regulatory network (GRN) used to model the interactions and control existing among molecules, proteins and other transcription factors in a biological system. The activities of the genes and their regulatory effects are controlled through their concentration levels defined by threshold functions. Qualitative and numerical studies of this network have, in general, revealed a lot of properties such as existence of periodic orbits, stable oscillation, chaos and steady states among others. This study applied the method of geometric singular perturbation to investigate the behaviour of the network within the threshold neighbourhood (known as singular states). The dynamics of the network is transformed into slow and fast systems at the singular states to enable the expected investigation with the use of GSP. Filippov's first order theory, Fenichel's persistence theorem among others were used to obtain the desired results.

Oelz, Dietmar. A mechanochemical model for symmetry breaking in Hydra spheroids
Speaker: Dietmar Oelz (The University of Queensland)
Time: 13:30 Fri 8 December
Place(s): 14-115
Author(s): Dietmar Oelz

Tissue morphogenesis involves the self-organized creation of patterns and shapes. In many cases details of underlying mechanisms are elusive, yet an increasing amount of experimental data suggests that chemical morphogens and mechanical processes are strongly coupled. Here, we develop and simulate a minimal model for the emergence of asymmetry in aggregates of the Hydra polyp based on mechanochemical coupling of surface stiffness and a morphogen concentration. We contrast this model with the classical morphogen patterning mechanisms based on Turing type reaction diffusion systems. In analogy to this classical mechanism, we carry out the stability analysis of the lower dimensional toy model and identify minimal conditions for symmetry breaking. Our results suggest that mechanochemical pattern formation underlies symmetry breaking in Hydra.

Stepanyants, Yury. Lumps and their interactions in the cylindrical Kadomtsev–Petviashvili equation
Speaker: Yury Stepanyants (University of Southern Queensland)
Time: 13:30 Thu 7 December
Place(s): 14-115
Author(s): Yury Stepanyants

We study solitary waves in the cylindrical Kadomtsev–Petviashvili equation (alias Johnson equation) that describes nonlinear wave processes in media with positive dispersion. This equation belongs to the class of completely integrable systems; however, its exact solutions were not studied in detail albeit some particular solutions have been obtained. By means of the Darboux–Matveev transform, we derive exact solutions in the form of fully localised two-dimensional solitary waves (lumps) and lump chains. One of the obtained solutions describes, in particular, the modulation instability of outgoing ring solitons and their disintegration onto a lump chain. We also derive solutions describing decaying lumps and lump chains of a complex spatial structure – ripplons. Then, we study normal and anomalous (resonant) interactions of lump chains with each other and with ring solitons. The results obtained agree with the numerical solutions of the Kadomtsev–Petviashvili equation.

Taimre, Thomas. Rare-event simulation techniques for structured fisheries models
Speaker: Thomas Taimre (The University of Queensland)
Time: 14:30 Tue 5 December
Place(s): 14-115
Author(s): Thomas Taimre

One of the main goals in fisheries management is to prevent the collapse of fish stocks. A key consideration therefore is the impact of different harvest strategies and environmental noise on the likelihood of future stock collapse, or quasi-extinction. Motivated by this problem, we consider several rare-event simulation techniques to increase the speed and accuracy of projections of stock collapse. We consider both a one-dimensional structured fisheries model and a multidimensional age-structured fisheries model in applying our techniques. We observe that the way in which catch is modelled has a substantial impact on the likelihood of quasi-extinction. We reach the overall conclusion that the use of rare-event simulation techniques for structured fisheries models is worthwhile when the probability of quasi-extinction is on the order of 10^{-2} or smaller.
This is joint work with Marijn Jansen and Michel Mandjes

Thornton, Aaron. Modelling Intrinsically Disordered Proteins using Mechanical Hoberman Spheres
Speaker: Aaron Thornton (CSIRO)
Time: 15:00 Tue 5 December
Place(s): 14-115
Author(s): Aaron W. Thornton

Intrinsically Disordered Proteins (IDPs) lack a stable ordered structure and behave unpredictably in the presence of other biomolecules. Resilin for example, found in bees knees, are the most efficient elastic materials in nature. Dynamic conformational ensembles of IDPs remain unresolved because of their ultrafast motion. By building a mechanical model based on Hoberman spheres, we are able to predict the contraction and expansion of these proteins in different environments. For the first time, we observed a non-linear response of expansion followed by contraction in the presence of crowder molecules such as glucose. The model points to an important parameter, namely the dielectric constant, that seems to govern such behaviour. Herein we present the mathematical model and experimental results that support a predictive model for the protein dynamics in different environments.

Timms, Liam. Saving elephants with rangers and real estate: optimizing conservation funding
Speaker: Liam Timms (The University of Melbourne)
Time: 14:00 Tue 5 December
Place(s): 14-115
Author(s): Liam Timms, Matthew Holden

Illegal harvest (poaching) and habitat loss are two of the greatest threats to wildlife. While, in theory, protected areas can alleviate populations from these threats, they must be enforced to achieve conservation goals. When faced with limited budgets, there is an inherent trade-off between acquiring property to protect against habitat loss versus spending that money to better enforce the existing area. This trade-off is exacerbated by enforcement being spread thinner, spatially, as area is acquired. To aid investment decisions between expanding versus better enforcing protected areas, we developed a general model of poaching effort and the population it threatens within a protected area (PA). In this model, we show that it is often optimal to increase anti-poaching enforcement in the existing PA before expanding it. A sensitivity analysis of our decision rule to changes in poacher behaviour shows that the optimality of initially prioritising enforcement over expansion can hold even when enforcement only mildly deters poaching. Calls for expansion often assume that the PA will be enforced effectively, however, this must be explicitly planned for when the target species is threatened by poaching. The methods developed here provide a useful starting point for conservation scientists and managers to explore trade-offs between increasing investments in protected area expansion and enforcement.

Watt, Simon. Chaotic flow in competitive exothermic-endothermic reaction systems
Speaker: Simon Watt (UNSW Canberra)
Time: 14:30 Fri 8 December
Place(s): 14-115
Author(s): Simon Watt

We study the effects of two-dimensional chaotic advection on a chemical system characterised by competitive exothermic and endothermic reactions. In previous studies, in which advective flow and reaction processes were assumed to dominate weak diffusive effects, two distinct behaviours were

observed in the system. The first, when the stirring is fast and the reaction is slow. In this case, flame quenching occurs. In contrast, when the stirring is slow and the reaction is fast, local temperature perturbations lead to a stationary flame with a complex filament structure. When the diffusion process is more influential, as for example in many microfluidic contexts, a third type of behaviour is possible, in which an expanding swirling travelling wave develops. We explore the diffusion-dominated behaviour in more detail.

Xu, Huansang. Equity Protection Swaps: A New Type of Risk Management Products for Pension Funds
Speaker: Huansang Xu (The University of Sydney)
Time: 17:00 Wed 6 December
Place(s): 14-115
Author(s): Huansang Xu

An equity protection swap (EPS) is a proposed new type of insurance product for pension accounts, which is largely based on an equity swap structure. It is a financial derivative, which is reminiscent of a total return swap but has also some features of the annuity insurance product known as the registered index-linked annuity (RILA). The buyer of an EPS agrees to share portfolio's gains with its provider if the realized return on the reference portfolio is above a predetermined positive level and obtain a partial protection if a loss on that portfolio occurs. Formally, a generic EPS consists of the protection and fee legs with different participation rates, which are negotiated by the provider of an EPS and its buyer. We first derive a general pricing formula for a standard EPS by obtaining the static hedging strategy based on traded European options. Next, we argue that it order to make the contract appealing to a typical holder of pension account, the provider should select an appropriate participation rate for the fee leg in relation to the protection level required by the holder so that fair premium for the contract at its inception date is null. We present numerical examples based on the market data to illustrate our theoretical findings and demonstrate the benefits of an EPS as an efficient portfolio's insurance tool for its holder.

Zanca, Adriana. Cell differentiation architectures
Speaker: Adriana Zanca (The University of Melbourne)
Time: 13:30 Wed 6 December
Place(s): 14-115
Author(s): Adriana Zanca

In multicellular organisms, stem cell differentiation, or specialisation, is critical for biological functions including tissue homeostasis and regeneration, and embryogenesis. Cell differentiation is often a multi-step process, with several intermediate states until a cell becomes fully differentiated. In circumstances such as response to injury, some cells are able to dedifferentiate, in other words move into a less differentiated state in their lineage. At stages throughout differentiation and dedifferentiation, cells may also undergo cell death. The process of differentiation, dedifferentiation and cell death can be modelled as a Markov process. In this talk, we consider the mean extinction times for cells with various differentiation architectures and their biological consequences. Even the simplest models can provide useful biological insight.

3. Category Theory, Homotopy Theory, and K-Theory

Borghi, Olivia. Commutativity in Higher Algebraic Objects
Speaker: Olivia Borghi (The University of Melbourne)
Time: 16:30 Tue 5 December
Place(s): 03-262
Author(s): Olivia Borghi

A symmetric monoidal category is a category equipped with a monoidal product that is uniquely commutative up to isomorphism. In this way the iterated monoidal product has an action from the symmetric groups. We can generalize this notion by allowing actions of from other permutative groups. Examples include braided monoidal categories, coboundary categories and ribbon braided monoidal categories. These generalized commutative monoidal categories find use in the representation theory of quantum groups (coboundary categories) and the study of TQFTs (ribbon braided monoidal categories). In this talk I will explain we can generalize the definition of symmetric monoidal ∞-category and ∞-operad in the same manner allowing a more generic notion of G-monoidal ∞-category and ∞-G-operad.

Clark, Alexander. Classifying t-structures on filtered tensor-triangulated categories
Speaker: Alexander Clark (The University of Melbourne)
Time: 14:30 Tue 5 December
Place(s): 03-262
Author(s): Alexander Clark

Associated to any essentially-small tensor-triangulated category (tt-category) is a particular (appropriately universal) locally ringed space, known as its Balmer spectrum. The Balmer spectrum recovers quasi-compact quasi-separated schemes from their tensor derived categories of perfect complexes. Recent work by G. Sahoo and U. Dubey generalises the classification of compactly-generated t-structures on the derived category of a Noetherian commutative ring, originally due to Alonso Tarrio et al, to a classification of appropriate t-structures on the derived category of a Noetherian scheme. We introduce the notion of a filtered tt-category, the most general setting where such a classification can take place, and consider examples, and non-examples.

Crowley, Diarmuid. Stably homeomorphic 4-manifolds
Speaker: Diarmuid Crowley (The University of Melbourne)
Time: 16:30 Wed 6 December
Place(s): 03-262
Author(s): Anthony Conway, Diarmuid Crowley and Mark Powell

Two 4-manifolds are called stably homeomorphic if they become homeomorphic after taking connected sums with products of 2-spheres. Determining whether two 4-manifolds with the same fundamental group are stably homeomorphic is a problem for which we have many computational tools.
On the other hand, classifying stably homeomorphic 4-manifolds is generally a much harder problem. To illustrate some of the challenges here, I will present examples of 4-manifolds with boundary, where there are infinitely many homotopy classes within a given stable homemorphism class. The detecting invariant is a generalisation of Boyer's boundary invariant from the simply-connected case.
This is a report on joint work with Anthony Conway and Mark Powell.

Deng, Bill. The $RO(G)$-graded cohomology of $E_{\Sigma_2}C_2$
Speaker: Bill Deng (UNSW Sydney)
Time: 15:00 Tue 5 December
Place(s): 03-262
Author(s): Bill Deng

Singular cohomology and motivic cohomology can be extended to the equivariant setting to study spaces and varieties equipped with a G-action, where G is a finite group. In the topological case, $RO(G)$-graded cohomology has become an active area of research due to its recent application in resolving the long-standing Kervaire invariant one problem. In this talk, we present new results for the case where $G = K$ is the Klein four-group. We investigate the relationship between the equivariant motivic cohomology of the real field with a C_2-action, and its realisation in $RO(K)$-graded cohomology. In particular, we elucidate the structure of the Mackey-functor valued cohomology of the space $E_{\Sigma_2}C_2$ by studying the isotropy separation cofiber sequence.

Di Vittorio, Nicola. Introduction to the theory of 2-derivators
Speaker: Nicola Di Vittorio (Macquarie University)
Time: 13:30 Wed 6 December
Place(s): 03-262
Author(s): Nicola Di Vittorio

Derivators were introduced independently by Grothendieck and Heller in the 1980s with the aim of formalising homotopy theory. They realised that a consistent amount of this theory can be captured by working with collections of homotopy categories of diagram categories, a quotient of the full homotopy theory.
In the last few years, Riehl and Verity have been establishing the theory of ∞-cosmoi, well behaved $(\infty, 2)$-categories where one can develop $(\infty, 1)$-category theory. They noticed that much of the theory of ∞-cosmoi can be developed inside a quotient, the homotopy 2-category.
Inspired by these two lines of research, I introduced a 2-dimensional notion of derivator that formalizes these ideas. In this talk I will explain how this new notion can be used to generalise ∞-cosmology.

Fujii, Soichiro. Enrichment preserves fibrations
Speaker: Soichiro Fujii (Macquarie University)
Time: 14:30 Thu 7 December
Place(s): 03-262
Author(s): Soichiro Fujii

The notion of (Grothendieck) fibration can be defined internal to any 2-category K, and when K has oplax limits of 1-cells, there is a simple criterion for a 1-cell in K to be a fibration. In this talk, I will show that the 2-functor (-)-Cat : BICAT -¿ 2-CAT, mapping each bicategory B to the 2-category B-Cat of B-categories, preserves fibrations. Here, BICAT is the 2-category of bicategories, lax functors, and icons, and the fibrations in BICAT are exactly the pseudo functors which are locally (Grothendieck) fibrations. (Joint work with Steve Lack.)

Graham, Joshua. Equivariant Motivic Cohomology and it's relationship to Bredon Cohomology
Speaker: Joshua Graham (University of New South Wales)
Time: 14:00 Tue 5 December
Place(s): 03-262
Author(s): Joshua Graham

RO(G)-graded Bredon cohomology has proved a highly useful homotopy invariant for spaces with group action, with a significant part of this theory coming from the abundance of different coefficients that one can use. Within the last 10 years, mathematicians have found ways to extend Voevodsky's motivic cohomology to smooth schemes with group action, but sadly there is no way to use the same coefficients as one does for Bredon cohomology.
We show a potential solution to this, and moreover show how one can recover some of the topological comparison results that give conditions under which motivic and Betti cohomology coincide.

Hammet, Jayden. U_α-bordism: a refinement of complex bordism
Speaker: Jayden Hammet (The University of Melbourne)
Time: 16:00 Tue 5 December
Place(s): 03-262
Author(s): Jayden Hammet

In this talk I will introduce the U_α-bordism groups, which are the bordism theories corresponding to the α-fold cover of the stable unitary group, and describe the computation of their corresponding Thom spectra. I will also discuss some applications of these computations to contact geometry.

Hogan, Tamara. A knot theoretic interpretation of the Goldman-Turaev Lie bialgebra
Speaker: Tamara Hogan (The University of Melbourne)
Time: 14:00 Wed 6 December
Place(s): 03-262
Author(s): Dror Bar-Natan, Zsuzsanna Dancso, Tamara Hogan, Jessica Liu and Nancy Scherich

Arising in the early study of string topology, the Goldman-Turaev Lie bialgebra is a well-studied structure on the space of free immersed loops on a surface of genus g with n+1 punctures. The bracket and co-bracket in this structure involve smoothings of intersections between pairs of loops or between a loop and itself. More recently, in a series of papers, Alekseev, Kawazumi, Kuno and Naef showed that expansions (or finite-type invariants) of these structures are equivalent to solutions of the Kashiwara-Vergne (KV) equations. A similar correspondence between expansions of welded tangles and solutions to the KV equations is known due to Bar-Natan and Dancso.
Motivated by trying to understand the connection between these two different spaces and their expansions, in this talk I will describe the construction of a lift of the Goldman-Turaev structure in genus zero to the space of tangles in a handlebody. This is a report on forthcoming joint work with Dror Bar- Natan, Zsuzsanna Dancso, Jessica Liu and Nancy Scherich.

Hoshino, Keisuke. Double categories of relations relative to factorisation systems
Speaker: Keisuke Hoshino (Kyoto University)
Time: 15:00 Wed 6 December
Place(s): 03-262
Author(s): Keisuke Hoshino, Hayato Nasu

In any category with finite products, a relation between two objects is defined as a subobject of their product. Lawvere observed that for the composition of relations to be associative and unital, the category must be regular. Carboni, Kasangian, and Street addressed the bicategory of relations

on regular categories, while it is well-known that spans in finitely complete categories, which have been studied as an alternative for relations, similarly define bicategories. Carboni and Walters gave a characterisation for the bicategories of relations on regular categories in terms of *cartesian bicategory*, and later, Lack, Wood, and Walters extended their work and characterised bicategories of spans. More generally, Klein defined bicategories of relations for any finitely complete category $\mathbf{C}$ equipped with a *stable orthogonal factorisation system* (E, M), and observed that both bicategories of relations on regular categories and bicategories of spans are included as instances. He defined the notion of M-relations to $\mathbf{C}$ by replacing subobjects with M-subobjects; i.e., a M-relation from A to B is a morphism $X \to A \times B$ in M.

On the other hand, there are many cases in which one would like to deal with relations and the original category at the same time. *Double categories*, devised by Ehresmann, fulfil this desire by having vertical arrows as arrows in the original category and horizontal arrows as relations between objects. Lambert defined and characterised the double category of relations $\mathbb{R}\mathrm{el}(\mathbf{C})$ on a regular category $\mathbf{C}$, in which vertical arrows are morphisms in $\mathbf{C}$, and horizontal arrows are relations in $\mathbf{C}$. His method to construct an equivalence between an axiomatised double category of relations originated from the work of Niefield. She determined the condition for a double category to admit an oplax/lax adjoint to the double category of spans. Later, Aleiferi extended the result and characterised double categories of spans.

In our work, we extend their work to arbitrary relations defined on any stable factorisation system (E, M). Namely, we define a double category $\mathbb{R}\mathrm{el}_{\mathrm{E},\mathrm{M}}(\mathbf{C})$ for any finitely complete category $\mathbf{C}$ equipped with a stable factorisation system (E, M), and characterise those double categories in purely double categorical terms. Restated from the opposite point of view, we give a way to conceive a stable factorisation system on a finitely complete category as a double category satisfying some purely double categorical properties, and the left and right classes of stable factorisation system are recovered as the classes of *final morphisms* and *fibrations*, respectively. We also explore how properties for stable factorisation systems and those for double categories correspond to each other under our characterisation theorem. In light of these observations, we recover several previous works on relations in both the context of cartesian bicategories and the context of cartesian double categories.

Lemay, Jean-Simon. Hopf Monads on Biproducts
Speaker: Jean-Simon Lemay (Macquarie University)
Time: 13:30 Thu 7 December
Place(s): 03-262
Author(s): Jean-Simon Lemay

A Hopf monad, in the sense of Bruguières, Lack, and Virelizier, is a special kind of monad that can be defined for any monoidal category. Briefly, a Hopf Monad is a bimonad (also called a opmonoidal monad), such that canonical natural transformations that all bimonads called fusion operators are isomorphisms. Hopf monads are of interest since they can be used to lift structures to their Eilenberg-Moore categories such as monoidal closed structure, compact closed structure, star-autonomous structure, and even traced monoidal structure.

In this talk, I will talk about Hopf monads in the case of a category with finite biproducts, seen as a symmetric monoidal category. For biproducts, a Hopf monad is precisely characterized as a monad equipped with an extra natural transformation satisfying three axioms, which we call a fusion invertor. I will also consider three special cases: representable Hopf monads, idempotent Hopf monads, and when the category also has negatives. In these cases, the fusion invertor will always be of a specific form that can be defined for any monad. Thus in these cases, checking that a monad is a Hopf monad is reduced to checking one identity.

This is joint work with Masahito Hasegagwa, based on our paper: arXiv:2305.16667

Peng, Fei. Fourier–Mukai transforms for Deligne–Mumford stacks
Speaker: Fei Peng (The University of Melbourne)
Time: 13:30 Tue 5 December
Place(s): 03-262
Author(s): Fei Peng

A fundamental theorem of Orlov states that any fully faithful functor between the bounded derived categories of coherent sheaves on smooth projective varieties is naturally isomorphic to a Fourier–Mukai transform. Recently, Olander proved Orlov's theorem for smooth proper algebraic spaces. In this talk, I will briefly explain how we can establish Orlov's theorem for smooth proper Deligne–Mumford stacks over $\mathbb{C}$ building on Olander's work.

Singh, Chandan. ON RELATIVE STRUCTURE OF VIRTUAL TANGLES
Speaker: Chandan Singh (The University of Melbourne)
Time: 14:30 Wed 6 December
Place(s): 03-262
Author(s): Marcy Robertson, Chandan Singh

Operads provides a framework to systematically study abstract operations with multiple inputs and a single output. PROPs, which control operations with multiple inputs and multiple outputs, are a generalization of operads. Many interesting tensor categories can be seen as algebras over certain operads. For example, algebras over operad of parenthesized braids PaB are precisely braided monoidal categories. We introduce a relative operad called the operad of double disks DD_2 and we construct a 2–colored operad in groupoids based on DD_2 which governs the data of symmetric module tensor categories.
As an application, we define a 2–colored PROP of *tangles virtual tanlges*, denoted by $\mathcal{T}v\mathcal{T}$, and study their algebras and universal property. We prove that $\mathcal{T}v\mathcal{T}$ is universal among ribbon categories $\mathcal{R}$ and Brauer diagrams $\mathcal{B}$ equipped with strong monoidal functors between the two. It generalizes Shum-Reshetikhin-Turaev's result on the universality of the category of ordinary tangles $\mathcal{T}$. Moreover, it detects a deeper structure on the category of virtual knotted objects $v\mathcal{T}$ introduced by Brochier and recover the characterization of $v\mathcal{T}$ upon forgetting the colors on $\mathcal{T}v\mathcal{T}$.

Stoeckl, Kurt. Homotopy Probs and Other G-Operadic Structures.
Speaker: Kurt Stoeckl (The University of Melbourne)
Time: 17:00 Tue 5 December
Place(s): 03-262
Author(s): Kurt Stoeckl

A prop (prob) is a free symmetric (resp. braided) monoidal category generated by a single object. These are useful and ubiquitous structures, for instance encoding bialgebras and having applications in knot theory and topology. Both these classical structures are instances of group-operadic structures, for the symmetric group and braid group respectively. In this talk, we will characterise many G-operadic structures as algebras over quadratic groupoid coloured operads, which admit simple combinatorial descriptions via nestings. We will discuss ongoing work in proving this large family of operads are Koszul, and in using the Koszul machine to form and study homotopy weakened versions of their algebras.

Strumila, Michelle. An overview of infinity modular operads
Speaker: Michelle Strumila (Monash University)
Time: 15:00 Thu 7 December
Place(s): 03-262
Author(s): Michelle Strumila

Graphical sets are the cyclic, higher genus analogue of simplicial sets. They are used to represent infinity modular operads, just as dendroidal sets can be used to form operads. This talk explains quasi modular operads, one model of infinity modular operads

Voineagu, Mircea. Bredon motivic cohomology of real numbers
Speaker: Mircea Voineagu (University of New South Wales)
Time: 14:00 Thu 7 December
Place(s): 03-262
Author(s): Bill Deng, Mircea Voineagu

We determine all Bredon and Borel motivic cohomology groups and ring structures of real numbers. This generalizes to C_2equivariant schemes Voevodsky's computation of motivic cohomology ring of real numbers.

Vozzo, Raymond. Rigid 2-gerbes and applications
Speaker: Raymond Vozzo (The University of Adelaide)
Time: 16:00 Wed 6 December
Place(s): 03-262
Author(s): David M. Roberts and Raymond F. Vozzo

String structures can be studied in various ways from the point of view of higher geometry and one particularly pleasant method utilises bundle 2-gerbes and their geometry. In this talk I will describe a new strict model for studying the geometry of bundle 2-gerbes that is specifically designed to

make explicit calculations easier, with the motivating example being that of finding formulas for (the components of) geometric string structures. This is joint work with David Roberts.

4. Discrete Geometry

Pineda-Villavicencio, Guillermo. Counting and analysing faces of convex polytopes
Speaker: Guillermo Pineda-Villavicencio (Deakin University)
Time: 14:30 Wed 6 December
Place(s): 01-E212
Author(s): Guillermo Pineda-Villavicencio

A *convex polytope*, or simply *polytope*, is a geometric object in some Euclidean space $\mathbb{R}^d$ that is defined as the bounded intersection of a finite number of linear equalities:

$$P = \left\{ \begin{pmatrix} nx_1 \\ \vdots \\ x_d \end{pmatrix} \in \mathbb{R}^d \,\middle|\, \begin{array}{ccc} \alpha_{1,1}x_1 + \cdots + \alpha_{1,d}x_d & \leq & b_1 \\ \vdots & & \vdots \\ \alpha_{n,1}x_1 + \cdots + \alpha_{n,d}x_d & \leq & b_n \end{array} \right\}. \tag{1}$$

The subsets of the polytope P in (1) where some of these inequalities are equalities are the proper *faces* of P; these are polytopes of lower dimensions. The *dimension* of P in $\mathbb{R}^d$ is the maximum number of linearly independent points (vectors) in P minus one.
In the talk I will propose two lower bound conjectures on the number of faces of polytopes. The first conjecture concerns d-dimensional polytopes (or d-polytopes for short) with at most $3d-1$ vertices; a *vertex* in a polytope is a zero-dimensional face of the polytope. The second conjecture is about d-polytopes whose faces are Cartesian products of simplices; a d-dimensional *simplex* is a d-polytope whose $d+1$ vertices form an affinely independent set in $\mathbb{R}^d$, while the *Cartesian product* $P \times P'$ of a d-polytope $P \subset \mathbb{R}^d$ and a d'-polytope $P' \subset \mathbb{R}^{d'}$ is the Cartesian product of the sets P and P':

$$P \times P' = \left\{ \begin{pmatrix} p \\ p' \end{pmatrix} \in \mathbb{R}^{d+d'} \,\middle|\, p \in P,\, p' \in P' \right\}.$$

The second conjecture generalises Barnette's lower bound theorem from 1971–73 on the number of faces of *simplicial polytopes* (polytopes whose faces are all simplices) and Jockusch's lower bound conjecture from 1993 on the number of faces of *cubical polytopes* (polytopes whose faces are all cubes). A *d-dimensional cube* is a Cartesian product of d line segments.

Tritama, Aholiab. Ramsey number on the graphs of dual cyclic polytopes
Speaker: Aholiab Tritama (Deakin University)
Time: 14:00 Wed 6 December
Place(s): 01-E212
Author(s): Aholiab Tritama, Guillermo Pineda Villavicencio, Julien Ugon

Given two graphs, G and H, the Ramsey number $R(G,H)$ is the smallest integer n such that any graphs with more than n vertices contain either G or H. Now, we want to focus the investigation not on all graphs but restricted on the graphs of dual cyclic polytopes. Cyclic polytopes are appealing because they reach the maximum number of k-faces among the d-dimensional polytopes on n vertices for $0 \leq k \leq d-1$.

Yost, David. The excess degree of a polytope
Speaker: David Yost (Federation University Australia)
Time: 13:30 Wed 6 December
Place(s): 01-E212
Author(s): David Yost, Guillermo Pineda-Villavicencio and Jie Wang

Any vertex of a d-dimensional polytope must have degree at least d. It is natural to define the excess degree of a vertex as its degree minus the dimension, and the excess degree of a polytope as the sum of the excess degrees of its vertices. The excess degree of a polytope is routinely checked to equal $2e - dv$, where v and e are the numbers of its vertices and edges. We show that having low excess degree (not too much more than the dimension) imposes some strong restrictions on the structure of a polytope. Sample results include

(1) A d-polytope with excess 0, i.e. a simple polytope, must satisfy either $v = d+1, 2d, 3d-3$, or $v \geq 3d-1$ (unless $d=6$).

(2) There are no d-polytopes with excess degree in the range $[1, d-3]$.
(3) A d-polytope with excess $d-2$ must satisfy $v = d+2, 2d-1, 2d+1, 3d-2$, or $v \geq 3d$ (unless $d = 4$). Moreover, there is either a single vertex with excess $d-2$, or there are $d-2$ vertices with excess 1.
(4) If a d-polytope has excess $d-1$, then all nonsimple vertices have the same degree, and either $d = 3$ or $d = 5$.
(5) If a d-polytope has excess d, and $d \neq 3, 4, 6$, then there are d nonsimple vertices each with excess degree 1, and either $v = d+2, v = 2d+1$ or $v \geq 3d$.
(6) For $d \geq 8$, there is no d-polytope with excess $d+1$.
(7) For $d \geq 9$, any d-polytope with excess $d+2$ has $v = d+2$.
(8) There are no d-polytopes with excess degree in the range $[d+3, 2d-7]$.

Joint work with Guillermo Pineda-Villavicencio and Jie Wang.

5. Computational Mathematics

Carrasco, Sergio. New mixed finite element methods for the coupled convective Brinkman-Forchheimer and double-diffusion equations
Speaker: Sergio Carrasco (Universidad de Concepcion)
Time: 16:30 Wed 6 December
Place(s): 03-309
Author(s): Sergio Carrasco, Sergio Caucao, Gabriel N. Gatica

In this paper we introduce and analyze new Banach spaces-based mixed finite element methods for the stationary nonlinear problem arising from the coupling of the convective Brinkman-Forchheimer equations with a double diffusion phenomenon. Besides the velocity and pressure variables, the symmetric stress and the skew-symmetric vorticity tensors are introduced as auxiliary unknowns of the fluid. Thus, the incompressibility condition allows to eliminate the pressure, which, along with the velocity gradient and the shear stress, can be computed afterwards via postprocessing formulae depending on the velocity and the aforementioned new tensors. Regarding the diffusive part of the coupled model, and additionally to the temperature and concentration of the solute, their gradients and pseudoheat/pseudodiffusion vectors are incorporated as further unknowns as well. The resulting mixed variational formulation, settled within a Banach spaces framework, consists of a nonlinear perturbation of, in turn, a nonlinearly perturbed saddle-point scheme, coupled with a usual saddle-point system. A fixed-point strategy, combined with classical and recent solvability results for suitable linearizations of the decoupled problems, including in particular, the Banach-Necas-Babuska theorem and the Babuska-Brezzi theory, are employed to prove, jointly with the Banach fixed-point theorem, the well-posedness of the continuous and discrete formulations. Both PEERS and AFW elements of order $\ell \geq 0$ for the fluid variables, and piecewise polynomials of degree $\leq \ell$ together with Raviart-Thomas elements of order ℓ for the unknowns of the diffusion equations, constitute feasible choices for the Galerkin scheme. In turn, optimal a priori error estimates, including those for the postprocessed unknowns, are derived, and corresponding rates of convergence are established. Finally, several numerical experiments confirming the latter and illustrating the good performance of the proposed methods, are reported.

Cui, Tiangang. Scalable conditional transport maps using tensor trains
Speaker: Tiangang Cui (The University of Sydney)
Time: 14:30 Wed 6 December
Place(s): 03-309
Author(s): Tiangang Cui

We present a novel offline-online method to mitigate the computational burden of characterizing posterior random variables in statistical learning. In the offline phase, the proposed method learns the joint law of the parameter and the observable random variables in the tensor-train (TT) format. In the online phase, the resulting conditional transport can generate the posterior random variables given newly observed data in real time. Compared with normalizing flow techniques, the proposed method relies on function approximation and is equipped with a thorough performance analysis. The function approximation perspective also allows us to extend the capability of transport maps in challenging problems with high-dimensional observations and high-dimensional parameters using gradient-based dimension reduction. We demonstrate the efficiency of the proposed method on various statistical learning tasks in ordinary differential equations (ODEs) and partial differential equations (PDEs).

Duru, Kenneth. On entropy stable and mimetic discontinuous Galerkin finite element methods for the rotating thermal shallow water equations in complex geometries
Speaker: Kenneth Duru (The Australian National University)
Time: 14:00 Wed 6 December
Place(s): 03-309
Author(s): Kieran Ricardo, Kenneth Duru, David Lee

The rotating thermal shallow water equations (RTSW) have recently gained attention as a test bed for atmospheric models owing to the similarity in their mathematical structure to the full compressible Euler equations of atmospheric motion. These equations extend the rotating shallow water equations to include a temperature-like quantity, known as buoyancy, that is transported by the flow and modulates the pressure gradient forcing. However, the development of robust numerical methods for the RTSW on curvilinear meshes pose a significant challenge because the energy functional is no longer a convex function of the prognostic variables and will not ensure numerical stability when preserved. We will derive an entropy functional which is convex and which must be preserved in order to preserve model stability at the discrete level. We present a novel discontinuous Galerkin finite element method for numerical simulations of the RTSW in complex geometries using curvilinear meshes, with arbitrary accuracy. We will prove entropy stability and conservation of mass, buoyancy, vorticity, and energy. This is achieved by using novel numerical fluxes, summation-by-parts principle, and splitting the pressure and convection operators so that we can circumvent the chain rule at the discrete level. We will present numerical simulations on a cubed sphere mesh and verify the theoretical results. The numerical experiments demonstrate the robustness of the method for a regime of well developed turbulence, where it can be run stably without any dissipation. The entropy stable fluxes are sufficient to control the grid scale noise generated by geostrophic turbulence, eliminating the need for artificial stabilisation.

Gatica, Gabriel. Banach spaces-based mixed finite element methods for the convective Brinkman–Forchheimer problem and its coupling with Darcy equation
Speaker: Gabriel Gatica (Universidad de Concepcion)
Time: 16:00 Wed 6 December
Place(s): 03-309
Author(s): Sergio Caucao, Gabriel N. Gatica, Luis F. Gatica

We propose and analyze a new mixed finite element method for the nonlinear problem given by the stationary convective Brinkman–Forchheimer equations. In addition to the original fluid variables, the pseudostress is introduced as an auxiliary unknown, and then the incompressibility condition is used to eliminate the pressure, which is computed afterwards by a postprocessing formula depending on the aforementioned tensor and the velocity. As a consequence, we obtain a mixed variational formulation consisting of a nonlinear perturbation of, in turn, a perturbed saddle point problem in a Banach spaces framework. In this way, and differently from the techniques previously developed for this model, no augmentation procedure needs to be incorporated into the formulation nor into the solvability analysis. The resulting non-augmented scheme is then written equivalently as a fixed-point equation, so that recently established solvability results for perturbed saddle-point problems in Banach spaces, along with the well-known Banach–Nečas–Babuška and Banach theorems, are applied to prove the well-posedness of the continuous and discrete systems. The finite element discretization involves Raviart–Thomas elements of order $k \geq 0$ for the pseudostress tensor and discontinuous piecewise polynomial elements of degree $\leq k$ for the velocity. Stability, convergence, and optimal *a priori* error estimates for the associated Galerkin scheme are obtained. Numerical examples confirm the theoretical rates of convergence and illustrate the performance and flexibility of the method. In particular, the case of flow through a 2D porous media with fracture networks is considered. Extension to the coupling with the Darcy equation is briefly discussed.

Guo, Hailong. Discontinuous Galerkin methods for the Laplace-Beltrami operator on point cloud
Speaker: Hailong Guo (The University of Melbourne)
Time: 15:00 Thu 7 December
Place(s): 03-309
Author(s): Hailong Guo

In this talk, we will talk about high-order numerical algorithms for solving partial differential equations on point clouds. We introduce a new geometric error analysis framework which requires neither global continuity of surface patches nor exact geometric information, e.g., embedding maps, tangent spaces. The new framework provides us a fundamental tool to analyze discontinuous Galerkin (DG) methods

for the Laplace-Beltrami operator on point clouds. It is illustrated using examples of an interior penalty DG method for solving the Laplace-Beltrami equation and the corresponding eigenvalue problem with numerical verification.

Guo, Xin. Capacity dependent analysis for functional online learning algorithms
Speaker: Xin Guo (The University of Queensland)
Time: 13:30 Fri 8 December
Place(s): 03-309
Author(s): Xin Guo, Zheng-Chu Guo, and Lei Shi

This research provides convergence analysis of online stochastic gradient descent algorithms for functional linear models. Adopting the characterizations of the slope function regularity, the kernel space capacity, and the capacity of the sampling process covariance operator, significant improvement in the convergence rates is achieved. Both prediction problems and estimation problems are studied, where we show that capacity assumption can alleviate the saturation of the convergence rate as the regularity of the target function increases. We show that with a properly selected kernel, capacity assumptions can fully compensate for the regularity assumptions for prediction problems (but not for estimation problems). This demonstrates the significant difference between the prediction problems and the estimation problems in functional data analysis.

Inzunza, Cristian. A Banach spaces-based fully-mixed finite element method for the coupled poroelasticity and Poisson–Nernst–Planck equations
Speaker: Cristian Inzunza (Universidad de Concepcion)
Time: 17:00 Tue 5 December
Place(s): 03-309
Author(s): Gabriel N. Gatica, Cristian Inzunza and Ricardo Ruiz-Baier

We introduce and analyze a Banach space-based approach yielding a fully-mixed finite element method for numerically solving the Biot poroelasticity and Poisson–Nernst–Planck equations. For the poroelasticity we consider a four-field formulation, whose primary variables are the solid displacement, the fluid pressure, the fluid flux, and the total pressure. In turn, besides the electrostatic potential and the concentration of ionized particles, we introduce as new unknowns its gradients and the total ionic fluxes. The resulting continuous formulation, posed in suitable Banach spaces, consists of a coupled system of two saddle point-type problems, for the poroelasticity and Poisson equations, and a twofold saddle-point problem for the ionized particles concentration equations. The well-posedness of it is then analyzed by applying the classical Banach fixed point theorem, along with a smallness assumption on the data, the Babuška–Brezzi theory in Banach spaces, and a slight variant of a recently obtained solvability result for perturbed saddle point formulations in Banach spaces as well. The associated Galerkin schemes are addressed similarly, and the Brouwer theorem yields the existence of discrete solutions. A priori error estimates are derived for both approaches, and rates of convergence for specific finite element subspaces satisfying the required discrete inf-sup conditions, are established in 2D. Finally, several numerical examples illustrating the performance of the two methods and confirming the theoretical findings, are reported.

Khatun, Mst Shanta. Mathematical Modelling of Cancer Evolution
Speaker: Mst Shanta Khatun (The University of Sydney)
Time: 16:00 Tue 5 December
Place(s): 03-309
Author(s): Mst Shanta Khatun, J. Guy Lyons, and Peter S. Kim

Epithelial carcinogenesis, the initiation of epithelial cancer, develops from a series of genetic mutations during cell division. These successive mutations trigger unregulated cell growth through excessive cell division, migration, and invasion of the underlying extracellular matrix (ECM) of the tissue. In epithelial carcinogenesis, mutations accumulating in a cell play a crucial role by giving rise to heterogenous cell populations that interact and cooperate with each other and with their microenvironment, such as the ECM. In fact, the interaction and cooperation among heterogenous cells results in a cooperative tumor causing massive invasion of ECM. To model cancer, it is pivotal to investigate its evolutionary characteristics and behaviors. In this study, we build a cellular automata (CA) model of cancer evolution. Building on this model, we consider four mutations such as NOTCH, TP53, Hras and Sna2 that epithelial cells acquire to progress to a malignant tumor. These mutations reduce a cell's death rate, increase proliferation, and increase invasion. In addition, we consider two variations of these

mutations, cell-autonomous and microenvironmental. In the CA model, we focus on the microenvironmental interactions of the mutant cells arising through these mutations in forming a cooperative tumor. After investigation, we found that cells acquiring microenvironmental cooperative mutations, in contrast to non-cooperative cell-autonomous mutations, can give rise to a faster growing tumor by extensively invading the ECM.

Khot, Rekha Mallappa. Conforming virtual element method for forward and inverse source problems with rough data
Speaker: Rekha Mallappa Khot (Monash University)
Time: 16:00 Fri 8 December
Place(s): 03-309
Author(s): Rekha Khot, Neela Nataraj, and Nitesh Verma

This talk focuses on the analysis of conforming virtual element methods for general second-order linear elliptic problems with rough source terms and applies it to a Poisson inverse source problem with rough measurements. For the forward problem, when the source term belongs to $H^{-1}(\Omega)$, the right-hand side for the discrete approximation defined through polynomial projections is not meaningful even for standard conforming virtual element method. The modified discrete scheme introduces a novel companion operator in the context of conforming virtual element method and allows data in $H^{-1}(\Omega)$. This work has *three* main contributions. The *first* contribution is the design of a conforming companion operator J from the *conforming virtual element space* to the Sobolev space $V := H_0^1(\Omega)$, a modified virtual element scheme, and the *a priori* error estimate for the Poisson problem in the best-approximation form without data oscillations. The *second* contribution is the extension of the *a priori* analysis to general second-order elliptic problems with source term in V^*. The *third* contribution is an application of the companion operator in a Poisson inverse source problem when the measurements belong to V^*. The Tikhonov's regularization technique regularizes the ill-posed inverse problem, and the conforming virtual element method approximates the regularized problem given a finite measurement data. The inverse problem is also discretised using the conforming virtual element method and error estimates are established. Numerical tests on different polygonal meshes for general second-order problems, and for a Poisson inverse source problem with finite measurement data verify the theoretical results.

Lamichhane, Bishnu. A mixed finite element method for fourth and sixth-order partial differential equations
Speaker: Bishnu Lamichhane (The University of Newcastle)
Time: 15:00 Fri 8 December
Place(s): 03-309
Author(s): Bishnu Lamichhane

t is a challenge to approximate solutions to higher-order partial differential equations. We apply a mixed finite element approach to approximate solutions to sixth-order partial differential equations with clamped boundary conditions. We follow a constrained minimisation approach to formulate our saddle point problem and the finite element method. The new formulation allows us to use low-order finite element methods; hence, numerical approximation is efficient and easy.

Le Gia, Quoc Thong. Quasi-Monte Carlo sparse grid Galerkin FEMs for linear elasticity equations with uncertainties
Speaker: Quoc Thong Le Gia (University of New South Wales)
Time: 17:00 Fri 8 December
Place(s): 03-309
Author(s): Quoc Thong Le Gia

We explore a linear inhomogeneous elasticity equation with random Lamé parameters. The latter are parameterized by a countably infinite number of terms in separated expansions. The main aim of this work is to estimate expected values (considered as an infinite dimensional integral on the parametric space corresponding to the random coefficients) of linear functionals acting on the solution of the elasticity equation. To achieve this, the expansions of the random parameters are truncated, a high-order quasi-Monte Carlo (QMC) method is used to approximate the high dimensional integral, and a Galerkin finite element method (FEM) is introduced to approximate the solution of the elasticity equation over the physical domain. The error estimate from (1) truncating the infinite expansion, (2) the Galerkin FEM, and (3) the QMC quadrature rule are all studied and combined together. For this purpose, we show certain required regularity properties of the continuous solution with respect

to both the parametric and physical variables. To achieve our theoretical regularity and convergence results, we impose some reasonable assumptions on the expansions of the random coefficients. Some numerical results are delivered at the end.
This is joint work with Josef Dick, Kassem Mustafa, and T. Tran (UNSW, Sydney, Australia)

Li, Haibo. A preconditioned Krylov subspace method for linear inverse problems with general-form Tikhonov regularization
Speaker: Haibo Li (The University of Melbourne)
Time: 14:30 Thu 7 December
Place(s): 03-309
Author(s): Haibo Li

Tikhonov regularization is a widely used technique in solving inverse problems that can enforce prior properties on the desired solution. In this talk, we introduce a Krylov subspace based iterative method for solving linear inverse problems with general-form Tikhonov regularization term x^TMx, where M is a positive semi-definite matrix. An iterative process called the preconditioned Golub-Kahan bidiagonalization (pGKB) is designed, which implicitly utilizes a proper preconditioner to generate a series of solution subspaces with desirable properties encoded by the regularizer x^TMx. Based on the pGKB process, we propose an iterative regularization algorithm via projecting the original problem onto small dimensional solution subspaces. We analyze regularization effect of this algorithm, including the incorporation of prior properties of the desired solution into the solution subspace and the semi-convergence behavior of regularized solution. To overcome instabilities caused by semi-convergence, we further propose two pGKB based hybrid regularization algorithms. All the proposed algorithms are tested on both small-scale and large-scale linear inverse problems. Numerical results demonstrate that these iterative algorithms exhibit excellent performance, outperforming other state-of-the-art algorithms in some cases.

Li, Wei. Finite element interpolated neural networks for solving forward and inverse problems
Speaker: Wei Li (Monash University)
Time: 16:30 Tue 5 December
Place(s): 03-309
Author(s): Santiago Badia and Wei Li and Alberto F. Martín

We propose a general framework for solving forward and inverse problems constrained by partial differential equations, where we interpolate neural networks onto finite element spaces to represent the (partial) unknowns. The framework overcomes the challenges related to the imposition of boundary conditions, the choice of collocation points in physics-informed neural networks, and the integration of variational physics-informed neural networks. A numerical experiment set confirms the framework's capability of handling various forward and inverse problems. In particular, the trained neural network generalises well for smooth problems, beating finite element solutions by some orders of magnitude. We finally propose an effective one-loop solver with an initial data fitting step (to obtain a cheap initialisation) to solve inverse problems.

Liu, Yijia. Optimal parameter analysis of PML model and application of multi-block strategy in efficient numerical simulation of 2D acoustic waves in unbounded domain
Speaker: Yijia Liu (Australian National University)
Time: 13:30 Wed 6 December
Place(s): 03-309
Author(s): Yijia Liu, Kenneth Duru

In many applications, a reliable domain truncation scheme is essential for accurate wave numerical simulation. The perfectly matched layer (PML) is a perfectly non-reflecting layer that simulates the absorption of waves in numerical wave solvers. In general, PML is applied to continuous PDE and the layer is unbounded, which can indeed absorb all outgoing waves without reflections, regardless of incidence and frequency. However, once the PML is truncated and discretised, the PML is no longer a completely non-reflecting medium, because reflection error and the PML modeling error are caused by the PML layer. The numerical reflection error is mainly caused by the smoothness of the PML damping function on the PML interface. The modeling error is residual outgoing wave that bounce off the outer boundary of the PML and pass through the layer to pollute the solution. Therefore, in this presentation we discuss how to derive optimal PML parameters for the linear acoustic wave equation in two space dimension. Using a multi-block strategy, we present a numerical implementation of the

PML that completely eliminates the PML errors. Numerical experiments are presented to verify the analysis.

Mallon, Connor. Neural Level Set Topology Optimisation using Unfitted Finite Elements
Speaker: Connor Mallon (Monash University)
Time: 13:30 Tue 5 December
Place(s): 03-309
Author(s): Connor Mallon

To facilitate the widespread adoption of automated engineering design techniques, existing methods must become more efficient and generalizable. In the field of topology optimization, this requires the coupling of modern optimization methods with solvers capable of handling arbitrary problems. In this work, a topology optimization method for general multiphysics problems is presented. We leverage a convolutional neural parameterization of a level set for a description of the geometry and use this in an unfitted finite element method that is differentiable with respect to the level set everywhere in the domain. We construct the parameter to objective map in such a way that the gradient can be computed entirely by automatic differentiation at roughly the cost of an objective function evaluation. The method produces optimized topologies that are similar in performance yet exhibit greater regularity than baseline approaches on standard benchmarks whilst having the ability to solve a more general class of problems, e.g., interface-coupled multiphysics.

Narayanan, Ashvni. A tool for autoformalization of mathematics in Lean
Speaker: Ashvni Narayanan (The University of Sydney)
Time: 16:30 Fri 8 December
Place(s): 03-309
Author(s): Ashvni Narayanan

Formalization is the process of making a computer understand mathematics. It can often be difficult if one is not familiar with the nuances of the language. Automation attempts to make it easier for mathematicians to verify their results. We discuss a tool which has been created to aid autoformalization in a theorem prover called Lean. This is joint work with Prof Siddhartha Gadgil, Anand Tadipatri, Ayush Agarwal and Dr Navin Goyal.

Rojas, Sergio. Local minimum-residual a posteriori error estimates for a class of mixed finite element discretizations
Speaker: Sergio Rojas (Pontificia Universidad Católica de Valparaíso)
Time: 14:00 Fri 8 December
Place(s): 03-309
Author(s): Liliana Camargo, Ignacio Muga, Sergio Rojas, Patrick Vega

We introduce reliable and efficient a posteriori error estimates for a class of mixed formulations to solve partial differential equations involving a diffusion term. It combines a superconvergent postprocessing technique for the primal variable with an adaptive finite element method via residual minimization. Such a residual minimization procedure is performed on a local postprocessing scheme, commonly used in mixed finite element methods. Given the local nature of such an approach, the underlying saddle point problems associated with residual minimizations can be solved with minimal computational effort. We propose and study a posteriori error estimators based on an improvement of the built-in residual representative associated with residual minimization schemes, which adds, on the one hand, a residual term quantifying the mismatch between discrete fluxes and, on the other hand, the interelement jumps of the post-processed solution. We present several numerical experiments in two dimensions, including a standard mixed formulation for advection-diffusion problems using Brezzi–Douglas–Marini elements and a mixed Hybridizable Discontinuous Galerkin (HDG) formulation for the Helmholtz equation. The experiments perfectly fit our key theoretical findings and suggest that our estimates are sharp.

Rubiano Martinez, Andres Eduardo. Virtual element methods for coupled stress-assisted diffusion problems
Speaker: Andres Eduardo Rubiano Martinez (Monash University)
Time: 14:00 Tue 5 December
Place(s): 03-309
Author(s): Rekha Khot, Andr'es E. Rubiano, Ricardo Ruiz-Baier.

This paper aims first to perform continuous analysis of a mixed non-linear formulation for stress-assisted diffusion of a solute that interacts with an elastic material, and second to propose and analyse a virtual element formulation of the model problem. The two-way coupling mechanism between the Herrmann formulation for linear elasticity and the reaction–diffusion equation consists of a concentration-dependent active stress and a stress-dependent diffusion. The two sub-problems are analysed using the extended Ladyzhenskaya—Babuška–Brezzi theory for perturbed saddle-point problems. Besides, equipped with a Banach fixed-point strategy and an assumption on small data, the fully non-linear mixed formulation accomplishes well-posedness. The virtual element formulations for the uncoupled sub-problems are proven uniquely solvable by a fixed-point argument now in conjunction with appropriate projection operators. A priori error estimates are established and we test the accuracy and performance of the proposed method through computational simulations.

Ruiz Baier, Ricardo. Twofold saddle-point formulations for stress-altered diffusion models
Speaker: Ricardo Ruiz Baier (Monash University)
Time: 14:30 Fri 8 December
Place(s): 03-309
Author(s): Bryan Gomez-Vargas, Kent-Andre Mardal, Ricardo Ruiz Baier, Vegard Vinje

We present a new stress/total-pressure formulation for poroelasticity that incorporates the coupling with steady nonlinear diffusion modified by stress. This nonlinear problem is written in mixed-primal form, which combines a perturbed twofold saddle-point system with an elliptic problem. We analyze the continuous formulation within the framework of abstract fixed-point theory and Fredholm alternative for compact operators. A mixed finite element method is proposed, and its stability and convergence are analyzed. The resulting model can be used to study the steady case of waste removal in the brain, providing insight into the transport of solutes in poroelastic structures under the influence of stress.

Shi, Lei. Classification with Deep Neural Networks
Speaker: Lei Shi (Fudan University)
Time: 15:00 Wed 6 December
Place(s): 03-309
Author(s): Lei Shi, Zihang Zhang and Ding-Xuan Zhou

Classification with deep neural networks (DNNs) has made impressive advancements in various learning tasks. Due to the unboundedness of the target function, generalization analysis for DNN classifiers with logistic loss remains scarce. Recent progress in establishing a unified framework of generalization analysis for both bounded and unbounded target functions is reported. The analysis is based on a novel oracle-type inequality, which enables us to deal with the boundedness restriction of the target function. In particular, for logistic classifiers trained by deep, fully connected neural networks, the optimal convergence rates are obtained only by requiring the Hölder smoothness of the conditional probability. Under certain circumstances, such as when decision boundaries are smooth and the two classes are separable, the derived convergence rates can be independent of the input dimension.

Skerritt, Matthew Paul. Computing and Optimising Fisher Information for Partially Observable Simple Birth Processes
Speaker: Matthew Paul Skerritt (RMIT University)
Time: 15:00 Tue 5 December
Place(s): 03-309
Author(s): Matthew P. Skerritt

Joint work with A. Eshragh, J.V. Ross, B. Salvy, T. McCallum.
We look at the problem of maximising the Fisher information for the statistical model of a partially observable simple birth process. The particulars of the model itself are not particularly salient; suffice to say that the computation of the Fisher information itself is intractable when approached from first principles, allowing for only cases with two observations to be computed at all.
It turns out that the Likelihood function (from which the Fisher information is calculated) can be calculated from a generating function. Exploiting the generating function allows more cases—in terms of the number of observations—to become tractable (although the computation times can still be long).
In this talk we will discuss the computation, the optimisations surrounding it, and (briefly) the results. We will also invite comments for further optimisations. The statistical model itself will only be outlined in the simplest terms necessary to understand the computation.

Turner, Ian. Multiscale modelling of heterogeneous porous media using implicit evolution equations
Speaker: Ian Turner (QUT)
Time: 14:00 Thu 7 December
Place(s): 03-309
Author(s): Ian Turner

We first review the well-known distributed microstructure modelling framework for simulating diffusive transport phenomena in a porous (binary) medium comprised of a connected phase surrounding disconnected inclusions. This model provides a realistic representation of the transport behaviour in the medium for a range of diffusivity ratios of the inclusion to the surrounding phase. However, a slight disadvantage is that it is computationally demanding due to the need to compute over the macroscopic and microscopic scales concurrently. By representing the integral exchange term appearing in the macroscopic averaged equation as a convolution integral with a kernel describing the fading memory effects, it is possible to reduce the fully coupled dual-scale model to a single implicit evolution equation. We compare the simulation results of this reduced model with the full dual-scale model to highlight not only its predictive capability, but also its superior computational performance.

Tushar, Jai. Optimal Control of Stationary Doubly Diffusive Flows on Two and Three Dimensional Bounded Lipschitz Domains: Numerical Analysis
Speaker: Jai Tushar (Monash University)
Time: 13:30 Thu 7 December
Place(s): 03-309
Author(s): Jai Tushar, Arbaz Khan, Manil T. Mohan

In this work, we propose fully nonconforming, locally exactly divergence-free discretizations based on lowest order Crouziex-Raviart finite element and piecewise constant spaces to study the optimal control of stationary double diffusion model presented in [Bürger, Méndez, Ruiz-Baier, SINUM (2019), 57:1318-1343]. The well-posedness of the discrete uncontrolled state and adjoint equations is discussed using discrete lifting and fixed point arguments, and convergence results are derived rigorously under minimal regularity. Building upon our recent work [Tushar, Khan, Mohan, arXiv (2023)], we derive a second-order sufficient optimality condition for the control problem, which ensures local optimality of a reference control in a $\boldsymbol{L}^s$-neighbourhood and use it along with an *optimize-then-discretize* approach to prove optimal order a *priori* error estimates for the control, state and adjoint variables upto the regularity of the solution. The control problem is solved using a primal-dual active set strategy as a semi-smooth Newton method. Computational tests validate the predicted error decay rates and illustrate the proposed scheme's applicability to optimal control of thermohaline circulation problems.

Villa Fuentes, Segundo. A new fully-mixed formulation for the Navier–Stokes/Darcy equations
Speaker: Segundo Villa Fuentes (Monash University)
Time: 17:00 Wed 6 December
Place(s): 03-309
Author(s): Sergio Caucao, Ricardo Oyarzúa and Segundo Villa-Fuentes

In this work, we propose and analyze a fully-mixed formulation to couple fluid flow with porous media flow, governed by the Navier-Stokes and Darcy equations, respectively. The transmission conditions consist of mass conservation, balance of normal forces, and the Beavers-Joseph-Saffman law. Our approach involves introducing a modified pseudostress tensor dependent on pressure, the diffusive and convective terms of the fluid's Navier–Stokes equations, while employing the standard dual-mixed formulation for the Darcy model. The method results in a mixed variational formulation based on Banach spaces and a twofold saddle point structure. The key unknowns for the Navier-Stokes fluid are the pseudostress tensor, vorticity, and velocity, whereas the porous medium has velocity and pressure as its corresponding unknowns. We establish the well-posedness of both continuous and discrete formulations using a fixed-point strategy and the Banach–Nečas–Babuška and Banach's fixed point theorems. These results apply to arbitrary finite element subspaces under suitable stability assumptions. Additionally, we identify specific finite element subspaces that satisfy the necessary conditions and provide convergence analysis, demonstrating the method's optimal rate of convergence. Finally, we present several numerical results to illustrate the performance of the proposed method.

Wegert, Zachary James. A Hilbertian projection method for constrained level set-based topology optimisation

Speaker: Zachary James Wegert (Queensland University of Technology)
Time: 14:30 Tue 5 December
Place(s): 03-309
Author(s): Zachary J Wegert, Anthony P Roberts, Vivien J Challis

Topology optimisation is a class of PDE-constrained optimisation that seeks to minimise functionals that typically depend on the underlying domain and the solutions to the PDE constraints. In this talk we will introduce classical level set-based topology optimisation, the Hilbertian velocity extension-regularisation framework, and methods of constrained optimisation in level-set frameworks. Following this we will present an extension of the projection method proposed by Challis et al. (2008) for constrained level set-based topology optimisation that harnesses the extension-regularisation framework. We will consider several benchmark constrained topology optimisation problems and demonstrate that our proposed method is effective and provides several benefits. Alongside other recent works, the proposed Hilbertian project method makes significant progress towards improving the capacity of level set-based methods for constrained topology optimisation.

6. Dynamical Systems and Ergodic Theory

Al Dowais, Amal. Lyapunov exponents for open billiard flows
Speaker: Amal Al Dowais (The University of Western Australia)
Time: 14:30 Tue 5 December
Place(s): 35-519
Author(s): Amal Al Dowais

Abstract: This talk is about the interesting subject of Lyapunov exponents for open billiard flows. In this study, we investigate the estimation of the largest Lyapunov exponent for open billiards in two-dimensional and higher-dimensional domains. We also prove that the largest Lyapunov exponent is differentiable with respect to a billiard deformation parameter. This gives us a better understanding of how the largest Lyapunov exponent for open billiard systems behaves. In addition, we present a significant finding: a demonstration that all positive Lyapunov exponents for billiard flows within open billiards in Rd (where d is greater than or equal to 3) are all equal.

Atnip, Jason. Universal Gap Growth for Lyapunov Exponents of Perturbed Matrices
Speaker: Jason Atnip (The University of Queensland)
Time: 13:30 Tue 5 December
Place(s): 35-519
Author(s): Jason Atnip, Gary Froyland, Cecilia Gonzalez-Tokman

In this talk we study the quantitative simplicity of the Lyapunov spectrum of bounded matrix cocycles subjected to additive random perturbations. We establish, in dimensions 2 and 3, lower bounds on the gaps between consecutive Lyapunov exponents, depending only on the scale of the perturbation. A novelty of this work is that the bounds are uniform over all choices of the original sequence of matrices. Furthermore, we make no stationarity assumptions on this sequence. Hence, our results apply to random and sequential dynamical systems alike.

Cook, Andrew. Nowhere coexpanding functions
Speaker: Andrew Cook (Monash University)
Time: 14:00 Wed 6 December
Place(s): 35-519
Author(s): Andrew Cook, Andy Hammerlindl, Warwick Tucker

In this talk, we introduce a new C^1 class of "nowhere coexpanding functions" which is closed under composition and includes all C^3 functions whose Schwarzian derivative is non-positive. We demonstrate how a classic result by Singer (1978) can be generalised to apply to nowhere coexpanding functions.

dos Reis Cantarino, Marisa. u-Gibbs measure rigidity for uniformly expanding partially hyperbolic endomorphisms on surfaces
Speaker: Marisa dos Reis Cantarino (Monash University)
Time: 15:00 Wed 6 December
Place(s): 35-519
Author(s): Marisa dos Reis Cantarino

We say that a uniformly expanding map f has partially hyperbolic splitting if it has a Df-invariant unstable cone family. In the context of the two-dimensional torus, this means that f has a one-dimensional direction with weak expansion and a cone with strong expansion, that may contain infinitely many one-dimensional unstable directions depending on the past orbits of the point. We prove that, if f is not special (has more than one unstable direction for a point on T^2), then any fully supported ergodic u-Gibbs measure is absolutely continuous with respect to the Lebesgue measure, therefore being the unique absolutely continuous invariant measure for the system. We give examples with unstable leaves being either compact or dynamically transitive. As u-Gibbs measures are u-saturated, this implies a classification of these measures for the examples: either they are supported on a union of horizontal compact circles, or they are equivalent to the Lebesgue measure. This is a joint work with Bruno Santiago [UFF].

Gasiorek, Sean. Dynamics and Periodicity Conditions for the Integrable Boltzmann System
Speaker: Sean Gasiorek (California Polytechnic State University)
Time: 15:00 Thu 7 December
Place(s): 35-519
Author(s): Sean Gasiorek

Consider a simple mechanical system proposed by Boltzmann in the 1860's: a massive particle moves in a gravitational field with a linear boundary between the particle and the center of gravity. Reflections off the boundary are absolutely elastic and obey the billiard reflection law: angles of incidence and reflection are congruent. This system was recently shown by Gallavotti and Jauslin to have a second integral of motion. We study its dynamics and prove the existence of caustics, Cayley-type periodicity conditions, and more. This is joint work with Milena Radnović (University of Sydney).

González Robert, Gerardo. Dynamical aspects of complex continued fractions
Speaker: Gerardo González Robert (La Trobe University)
Time: 14:00 Thu 7 December
Place(s): 35-519
Author(s): Gerardo Gonzalez Robert

Some of the most relevant systems for representing real numbers, such as continued fractions or integer base expansions, can be understood by means of discrete dynamical systems. In this talk, I will give an overview of some complex continued fraction algorithms which also admit such an approach paying special heed to Hurwitz continued fractions. I will mention recent developments in the area including some of my most recent collaborations with Felipe Garcia-Ramos, Mumtaz Hussain, and Nikita Shulga.

Hammerlindl, Andy. Partial Hyperbolicity on Seifert manifolds
Speaker: Andy Hammerlindl (Monash University)
Time: 13:30 Thu 7 December
Place(s): 35-519
Author(s): Andy Hammerlindl

I will discuss recent advances in the study of partially hyperbolic dynamical systems defined on Seifert manifolds. This includes constructions of example systems and classification results. This is joint work with Mario Shannon and Rafael Potrie.

Jain, Sakshi. Piecewise Contracting Systems
Speaker: Sakshi Jain (None)
Time: 14:00 Tue 5 December
Place(s): 35-519
Author(s): Sakshi Jain

We study piecewise injective contracting maps on a compact subset of $\mathbb{R}^d$. We prove that generically the attractor and the set of discontinuities are disjoint, and hence the attractor consists of periodic orbits. In addition, we prove that piecewise injective contractions are generically topologically stable.

Leplaideur, Renaud. Selection in ergodic Optimization
Speaker: Renaud Leplaideur (Université de la Nouvelle Calédonie)
Time: 14:30 Thu 7 December
Place(s): 35-519
Author(s): Renaud Leplaideur & Jairo Mengue

Ergodic theory aims to describe most of the trajectories of a given dynamical system. For that, thermodynamic formalims selects one particular measure via a variational principle. One chooses an equilibrium state μ_ϕ which maximizes the free energy for a given potential ϕ. Ergodic optimization is another way to select a measure: one choose a measure maximizing the integral of the potential. There is a relation between two ways. Introducing a parameter β that is the inverse of the temperature,any accumulation point for $\mu_{\beta.\phi}$ is ϕ-maximizing. The question is to study convergence and selection of the accumulation points among maximizing measures. I shall present some new advances in that topic.

McAlister Caffarel, Natalia. Computer-aided proofs for blenders
Speaker: Natalia McAlister Caffarel (Monash University)
Time: 13:30 Wed 6 December
Place(s): 35-519
Author(s): Natalia McAlister

I will be discussing methods for rigorously detecting blenders and other geometric structures that imply chaos. By definition, a blender is an object whose unstable manifold, when looking at certain intersections, seems to have a greater dimension than it actually does. This descriptive definition cannot be verified on a computer. The first step is then stating necessary conditions for establishing the existence of a blender in a computer-friendly way. I will be doing this by discussing the example of the Hénon map. These methods could potentially be extended to more challenging examples.

Peters, Joshua. Prevalence of stability for smooth Blaschke product cocycles fixing the origin
Speaker: Joshua Peters (None)
Time: 15:00 Tue 5 December
Place(s): 35-519
Author(s): Cecilia González-Tokman and Joshua Peters

This work investigates the stability properties of Lyapunov exponents of transfer operator cocycles from a measure-theoretic perspective. Our results focus on so-called Blaschke product cocycles, a class of random dynamical systems amenable to rigorous analysis. We show that prevalence of stability is related to the dimension of the base system's domain, Ω. When $\Omega = S^1$, we show that stability is prevalent among smooth monic quadratic Blaschke product cocycles fixing the origin by constructing a so-called probe. For higher dimensional Ω, we show that a probe does not exist, thus providing strong evidence that stability is not prevalent in this setting. Finally, through a perturbative method we show that almost every smooth Blaschke product cocycle fixing the origin is stable.

Roberts, John. Rotations of the circle and their symbolic dynamics
Speaker: John Roberts (University of New South Wales)
Time: 14:00 Fri 8 December
Place(s): 35-519
Author(s): John A G Roberts

In circle rotations with a binary symbolic dynamics, a critical curve is the locus of parameters for which the boundaries of the partition that defines the symbolic dynamics are connected via a prescribed number of iterations and symbolic itinerary. We study the arithmetical and geometrical properties of these curves in parameter space, including the way they delineate regions with different symbolic encodings.
This is joint work with Asaki Saito (Hakodate) and Franco Vivaldi (London).

Tucker, Warwick. The Songling system has exactly four limit cycles
Speaker: Warwick Tucker (Monash University)
Time: 14:30 Fri 8 December
Place(s): 35-519
Author(s): Warwick Tucker

Determining how many limit cycles a planar polynomial system of differential equations can have is a remarkably hard problem. One of the main difficulties is that the limit cycles can reside within areas of vastly different scales. This makes numerical explorations very hard to perform, requiring high precision computations, where the necessary precision is not known in advance. Using rigorous computations, we can dynamically determine the required precision, and localise all limit cycles of a given system. We prove that the Songling system of planar, quadratic polynomial differential equations has exactly four limit cycles. Furthermore, we give precise bounds for the positions of these limit cycles using rigorous computational methods based on interval arithmetic. The techniques presented here are applicable to the much wider class of real-analytic planar differential equations.
This is joint work with Zbigniew Galias.

Ward, Benjamin. Irrational rotations in higher dimensions
Speaker: Benjamin Ward (La Trobe University)
Time: 14:30 Wed 6 December
Place(s): 35-519
Author(s): Ben Ward

Fix $\alpha > 0$ and consider the sequence $(n\alpha)_{n\geq 1}$ modulo the unit interval. To each term in the sequence attach some shrinking neighbourhood. How many points in the unit interval lie in some neighbourhood of the sequence? How many points lie in some neighbourhood of the sequence infinitely often, or only finitely often? Each of these questions has been answered to various degrees. In this talk I will give a brief survey of such results before considering analogous questions in higher dimensions. In particular I will mention recent works with various collaborators including Victor Beresnevich, Shreyasi Datta, Anish Ghosh, and Mumtaz Hussain.

Wechselberger, Martin. (Hidden) multiple timescales and the parametrisation method in geometric singular perturbation theory
Speaker: Martin Wechselberger (The University of Sydney)
Time: 13:30 Fri 8 December
Place(s): 35-519
Author(s): Ian Lizarraga, Bob Rink, Martin Wechselberger

We present a novel method for computing slow manifolds and their fast fibre bundles in geometric singular perturbation problems. This coordinate-independent method is inspired by the parametrisation method introduced by Cabré, Fontich and de la Llave. By iteratively solving a so-called conjugacy equation, our method simultaneously computes parametrisations of slow manifolds and fast fibre bundles, as well as the dynamics on these objects, to arbitrarily high degrees of accuracy. We show the power of this *top-down* method for the study of systems with multiple, i.e., three or more timescales. In particular, we highlight the emergence of *hidden* timescales and show how our method can uncover these surprising multiple timescale structures.

7. Equity, Diversity and Inclusion in Mathematics

Ball, Rowena. Equity and diversity OF mathematics
Speaker: Rowena Ball (The Australian National University)
Time: 14:00 Thu 7 December
Place(s): 67-442
Author(s): Rowena Ball

In what sense is Western mathematics Western? How did European mathematics colonise the minds and curriculums of the whole world, to the exclusion or suppression of non-Western, Indigenous, and vernacular mathematics? In this talk I shall describe our research and teaching initiative to decolonise and strengthen and grow mathematics as a discipline, and attract and retain students from under-represented groups, through investigations of cross-cultural mathematics and truth-telling in mathematics history. We link achieving a diversity of people IN mathematics to a genuine diversity OF mathematics.

Burton, Benjamin. Diversity in academic competitions: Success, failures, and works in progress
Speaker: Benjamin Burton (The University of Queensland)
Time: 14:30 Thu 7 December
Place(s): 67-442
Author(s): Benjamin Burton

The International Olympiad in Informatics (IOI) is one of the five Science Olympiads, and a pinnacle of achievement for secondary students worldwide. Now in its 35th year, the IOI has its share of diversity problems, including an extreme gender imbalance, difficult host countries for LGBTIQ participants, and a severe underrepresentation of some geographic regions. Here we will talk through two recent initiatives to improve diversity and inclusion in the IOI: a new *IOI Ally Programme* (largely successful), and efforts to improve diversity on the committee that sets policy (largely unsuccessful). We will also discuss some of the challenges that come from the highly international and democratic nature of the IOI, which differentiate this from a typical university setting.
The speaker is a long-standing member of the committee that oversees the IOI, and is currently serving as President.

Joshi, Nalini. Vision for Equity, Diversity and Inclusion in the AustMS: past, current and future actions (Part I)
Speaker: Nalini Joshi (The University of Sydney)
Time: 14:30 Wed 6 December
Place(s): 67-442
Author(s): Nalini Joshi

The AustMS Equity, Diversity and Inclusion (EDI) Committee was formed in August 2018. Since that time, it has shaped major initiatives of AustMS aimed towards improving Equity, Diversity and Inclusion for the Australian mathematical community. Major steps include the creation of the annual Dr Yunupingu Lecture and EDI special session at annual meetings, and the formulation and implementation of the Code of Conduct and procedures for reported violations of the code. This talk reports on its work in detail and invites discussion on current matters under consideration.
The discussion will be facilitated by Ell Baldwin, Ed Green and Nalini Joshi.

Joshi, Nalini. Vision for Equity, Diversity and Inclusion in the AustMS: past, current and future actions (Part II)
Speaker: Nalini Joshi (The University of Sydney)
Time: 15:00 Wed 6 December
Place(s): 67-442
Author(s): Nalini Joshi

This is a continuation of the discussion about future steps for improving Equity, Diversity and Inclusion for the Australian mathematical community (see "Vision for Equity, Diversity and Inclusion in the AustMS: past, current and future actions (Part I)" for the previous part). The discussion will shape the formulation of next steps undertaken by the AustMS EDI Committee.
The discussion will be facilitated by Ell Baldwin, Ed Green and Nalini Joshi.

Kamgarpour, Masoud. Can we communicate maths better?
Speaker: Masoud Kamgarpour (The University of Queensland)
Time: 14:00 Wed 6 December
Place(s): 67-442
Author(s): Masoud Kamgarpour

Have you ever been in a maths lecture where you felt loss? For me, being lost is an omnipresent experience. The length of time this has been going on (decades!) helps me cope with the feelings of inadequacy, stupidity, and frustration that invariably creep in when one tries/hopes/prays to understand but comes up short. I think this feeling is quite common, especially among our students. I will use this opportunity to hav a discussion with the audience regarding how we can communicate math in a more inclusive way.

Robertson, Marcy. What if Sherman Alexie were a mathematician ?
Speaker: Marcy Robertson (The University of Melbourne)
Time: 13:30 Thu 7 December
Place(s): 67-442
Author(s): Marcy Robertson
TBD

South, Leah. A plan for reducing sexual assault and sexual harassment
Speaker: Leah South (Queensland University of Technology)
Time: 15:00 Thu 7 December
Place(s): 67-442
Author(s): Leah South, Kathleen Mullen
Sexual assault and sexual harassment (SASH) disproportionately affect women, transgender people and people of diverse genders. In response to the National Student Safety Survey and our lived experiences, the QUT Faculty of Science devised a SASH Action Plan. The plan has four key areas: training, awareness, reporting & support, and onboarding & workspaces. Although the plan is in its early implementation stages, we have already seen some success with initiatives such as our respectful conduct workshops for HDR students. The faculty is piloting new approaches for preventing SASH in learning and teaching as part of this plan, with resources being rolled out across all faculty Canvas pages. In this talk, I will describe lessons we've learned along the way and our ideas for reducing SASH risk in STEM.

Timms, Liam. Creating inclusive classrooms in mathematics
Speaker: Liam Timms (The University of Melbourne)
Time: 13:30 Wed 6 December
Place(s): 67-442
Author(s): Rianna Bell, Ashlee Caddell, Liam Timms, Ava Greenwood, Matthew Davis,
Inclusive classrooms are essential for students effectively learning mathematics, a goal complicated by mathematics as a discipline traditionally lacking diversity. To promote diversity and inclusion by combatting discrimination and harassment, the University of Queensland School of Mathematics and Physics (SMP) launched the Classroom Inclusivity project. The project team, consisting of student tutors and academics, used our lived experience and teaching expertise to develop three resources. First, we created educational slides to help staff and students recognise discrimination, harassment, and bullying in the classroom, as well as how to take action against this behaviour. These slides were informed by both EDI literature and the student project members' experiences within SMP. The SMP website and learning management system provided an effective method to deliver this resource to both staff and SMP-taught students. Second, we developed a tutor workshop on fostering inclusive classrooms and how to address and report inappropriate behaviour. Finally, we recruited several staff to become "Inclusivity Champions". Each Champion is responsible for either a large SMP course or a particular student cohort (e.g. 1st year calculus, research students). Students who have inclusivity concerns are encouraged to approach a Champion, who ensure the concerns are properly addressed.

8. Functional Analysis

Abramov, Vyacheslav. Fixed point theorem for an infinite Toeplitz matrix and its extension to general infinite matrices
Speaker: Vyacheslav Abramov (N/A)
Time: 17:00 Wed 6 December
Place(s): 35-519
Author(s): Vyacheslav Abramov
In this talk we discuss the fixed point equation for an infinite Toeplitz matrix with real nonnegative entries. The proof of the main result is based on an application of a variant of the fixed point theorem of M. A. Krasnosel'skii. The results are then extended for the fixed point equations with infinite matrices of a general type.

Alexander, Angus. An index pairing in scattering theory
Speaker: Angus Alexander (University of Wollongong)
Time: 16:30 Wed 6 December
Place(s): 35-519
Author(s): Angus Alexander

For Schrödinger operators on $L^2(\mathbb{R}^n)$, the wave operators of scattering theory can be shown to have a rather simple universal form. This universal form allows one to recognise the classical Levinson's theorem, which computes the number of eigenvalues, as an index pairing between the K-theory class of the scattering operator and an appropriate spectral triple. In low dimensions, there are topological obstructions to the existence of such a pairing which are of particular interest.

David, Farrell. An Abstract Approach to Principal Symbol Calculus
Speaker: Farrell David (UNSW Sydney)
Time: 16:00 Wed 6 December
Place(s): 35-519
Author(s): Farrell David

Partial differential operators are polynomial combinations of the usual partial derivative operators, where the polynomial (the "symbol") may have non-constant coefficients. The action of a partial differential operator is the same as first applying the Fourier transform, multiplying by the symbol, and then applying the inverse Fourier transform. Pseudodifferential operators, or PSDOs for short, generalise partial differential operators by allowing non-polynomial symbols. Examples of PSDOs include partial differential operators and their inverses, should they exist.
Those PSDOs whose symbols, like polynomials, have a decomposition into homogeneous terms are called *classical* PSDOs. The mapping taking a classical PSDO to the highest order homogeneous part of its symbol is a homomorphism, taking operator composition to function multiplication. In this talk we will explore a recent construction giving an abstract C^*-algebraic approach to this homomorphism, and future directions for this work.

Lu, Jimeng. Pisier's Question: Steinberg Theorem Revisited
Speaker: Jimeng Lu (None)
Time: 17:00 Tue 5 December
Place(s): 35-519
Author(s): Jimeng Lu

In 1981 G. Pisier conjectured that every bounded convolution operator on $L_{p,\infty}(G)$ is automatically bounded on $L_p(G)$ if G is a compact Abelian group and $1 < p < 2$. This conjecture has been proved affirmatively by A.M. Steinberg in 1984. We present a new approach to this conjecture under a condition weaker than that of Steinberg, which applies interpolation theory for the couple (L_0, L_2).

Scheckter, Thomas. Noncommutative L^p Spaces are Primary
Speaker: Thomas Scheckter (UNSW Sydney)
Time: 16:30 Fri 8 December
Place(s): 35-519
Author(s): Thomas Scheckter

A Banach space is said to be primary if for any complemented subspace X, either X or it's orthogonal complement is isomorphic to the original Banach space. It is surprising, given the fundamental nature of this property for Banach space geometry, that it has remained unknown whether or not noncommutative L^p spaces are primary. Here we provide a simple proof for the hyperfinite type II_1 factor $\mathcal{R}$, by appealing to techniques from Ramsey theory and harmonic analysis.

Sims, Aidan. Reconstruction of Lie groupoids from spectral data
Speaker: Aidan Sims (University of Wollongong)
Time: 16:00 Fri 8 December
Place(s): 35-519
Author(s): Aidan Sims and Anna Duwenig

Connes' theorem (credit is also due to Rennie and Varilly) says that you can reconstruct a nice enough manifold from the data of a suitable commutative spectral triple—that is, from spectral data. Renault's theorem (credit is also due to Feldman–Moore and Kumjian) says that you can reconstruct a topological twist over an étale groupoid from the associated Cartan pair of C^*-algebras—again, from spectral data. I'll describe what you get if you put these two theorems to work together.

Zhao, Hongyin. Kuroda's theorem for n-tuples in semifinite factors
Speaker: Hongyin Zhao (University of New South Wales)
Time: 16:30 Tue 5 December
Place(s): 35-519
Author(s): Hongyin Zhao

The classical Kuroda's theorem reads as follows: Let a be a self-adjoint operator on a separable Hilbert space H, if $\|\cdot\|$ is a symmetric norm that is not equivalent to trace norm, then for arbitrary $\varepsilon > 0$, there exists a diagonal operator d on H such that $\|a-d\| < \varepsilon$. When we consider self-adjoint operators affliated with a von Neumann algebra, the original techniques no loner works. In this talk, we will present our recent work of the extension of Kuroda's theorem to the setting of n-tuples in semifinite von Neumann factors, and in the case when $n = 1$ we present an extension of Kuroda's theorem to semifinite von Neumann algebras.

9. Geometric Analysis

Broder, Kyle. A Locality Theorem for Einstein Metrics on Compact Complex Manifolds
Speaker: Kyle Broder (The University of Queensland)
Time: 16:00 Tue 5 December
Place(s): 08-212
Author(s): Kyle Broder and Artem Pulemotov

Einstein metrics have long played an important role in geometry, typically motivated as the leading candidates for canonical metrics. A long-standing problem (going back at least 40 years) has been whether the presence of a metric with good curvature properties on an Einstein manifold forces the Einstein metric to inherit such properties. In a recent joint work with Artem Pulemotov, we discovered that for a natural class of second Chern Einstein Hermitian metrics, a positive answer to this question may be given. For instance, if X is a compact complex manifold with both a second Chern Ricci-flat metric Hermitian metric and a Kähler metric that is non-positively curved, the second Chern Ricci-flat metric inherits the Kähler property. This implies that all second Chern Ricci-flat metrics on a complex torus are flat.

Flook, Marcus. Flows of real hypersurfaces immersed in complex space by Levi curvature
Speaker: Marcus Flook (Australian National University)
Time: 14:30 Wed 6 December
Place(s): 08-212
Author(s): Marcus Flook, Ben Andrews

In $\mathbb{C}^n$, domains of holomorphy with sufficiently regular boundary can be characterised by (Levi) pseudoconvexity, which is defined by the positive-semidefiniteness of the Levi form. Inspired by research from Huisken and Klingenberg [1], we discuss flows of CR hypersurfaces by the trace of the Levi form. This flow is analogous to the mean curvature flow, however with an additional degeneracy which yields different conditions on long term existence. We also discuss future directions of the work.
[1] G. Huisken, W. Klingenberg, Flow of real hypersurfaces by the trace of the Levi form, Math. Res. Lett. 6 (1999), no. 5-6, 645–661.

Gazwani, Mashniah. Curvature diffusion of planar curves with generalised Neumann boundary conditions inside cones
Speaker: Mashniah Gazwani (The University of Newcastle)
Time: 14:00 Wed 6 December
Place(s): 08-212
Author(s): Mashniah Ali M Gazwani

We study families of smooth immersed regular planar curves $\alpha : [-1,1] \times [0,T) \to \mathbb{R}^2$ satisfying the fourth order nonlinear curve diffusion flow with generalised Neumann boundary conditions inside cones. We show that if the initial curve has sufficiently small oscillation of curvature then this remains so under the flow. Such families of evolving curves either exist for a finite time, when an end of the curve has reached the tip of the cone or the curvature has become unbounded in L^2, or they exist for all time and converge exponentially in the C^∞- topology to a circular arc that, together with the cone boundary encloses the same area as that of the initial curve and cone boundary.

Gover, Rod. Conformal aspects of submanifolds and curves
Speaker: Rod Gover (University of Auckland)
Time: 13:30 Thu 7 December
Place(s): 08-212
Author(s): Rod Gover

We show that the equations for unparametrised conformal geodesics are the special case of a uniform notion of distinguished submanifolds. Moreover this class of special submanifolds is exactly the class that is weakly conformally geodesic, meaning that ambient conformal geodesics remain in the submanifold. For conformal geodesics and and such distinguished submanifolds there is an essentially uniform way to construct first integrals from suitable solutions of first BGG equations.
Moreover the notions of minimal submanifolds, CMC submanifolds, and related concepts are also nicely captured in the tractor theory for submanifolds that we develop, and this also means these notions are generalised in that they are well defined at the conformal singularities of metrics, as arise in Poincare-Einstein (and more generally conformally compact metrics). This applies in particular to geodesics which may be viewed as minimal 1-manifolds. This description of minimal submanifolds also provides simpler proofs of some recent results in the literature, and this will be described.
This is joint work with Sean Curry and Daniel Snell

Ho, Pak Tung. Results related to prescribing Gaussian curvature and geodesic curvature
Speaker: Pak Tung Ho (Tamkang University)
Time: 15:00 Fri 8 December
Place(s): 08-212
Author(s): Pak Tung Ho

I will first talk about results related to prescribing Gaussian curvature on surfaces. Then I will talk about results related to prescribing Gaussian curvature or geodesic curvature on surfaces with boundary.

Hong, Min-Chun. On Chen's conjecture for biharmonic hypersurfaces
Speaker: Min-Chun Hong (The University of Queensland)
Time: 13:30 Fri 8 December
Place(s): 08-212
Author(s): Min-Chun Hong

A longstanding conjecture on biharmonic submanifolds, proposed by Chen in 1991, is that any biharmonic submanifold in a Euclidean space is minimal. Recently, with Fu and Zhan, we find new techniques to settle Chen's conjecture on biharmonic hypersurfaces in $\mathbb{R}^6$ and the BMO conjecture on biharmonic hypersurfaces in $\mathbb{S}^6$.

Krummel, Brian. Analysis of singularities of area minimizing currents
Speaker: Brian Krummel (The University of Melbourne)
Time: 14:30 Fri 8 December
Place(s): 08-212
Author(s): Brian Krummel and Neshan Wickramasekera

In his monumental work in the early 1980s, Almgren showed that the singular set of an n-dimensional locally area minimizing submanifold T has Hausdorff dimension at most $n-2$. The main difficulty is that higher codimension area minimizers can admit branch point singularities, i.e. singular points at which one tangent cone is a plane of multiplicity two or greater. Almgren's lengthy proof showed first that the set of non-branch-point singularities has Hausdorff dimension at most $n-2$ using an elementary argument based on tangent cone type, and developed a powerful array of ideas to obtain the same dimension bound for the branch separately. In this strategy, the exceeding complexity of the argument stems largely from the lack of an estimate giving decay of T towards a unique tangent plane at a branch point.

We will discuss a new approach to this problem (joint work with Neshan Wickramasekera). In this approach, the set of singularities (of a fixed integer density q) is decomposed not as branch points and non-branch-points, but as a set $\mathcal{B}$ of branch points where T decays towards a (unique) plane faster than a fixed positive power of the scale, and the complementary set $\mathcal{S}$. Using a new intrinsic frequency function for T relative to a plane and a blow-up method of L. Simon and Wickramasekera, we show that T has a unique non-planar tangent cone at $\mathcal{H}^{n-2}$-a.e. point of $\mathcal{S}$ and T is asymptotic to

a unique homogeneous harmonic multi-valued function at $\mathcal{H}^{n-2}$-a.e. a.e. point of $\mathcal{B}$. It follows that the singular set of T is in fact countably $(n-2)$-rectifiable.

McCoy, James. Higher order linear curvature flow
Speaker: James McCoy (The University of Newcastle)
Time: 14:30 Thu 7 December
Place(s): 08-212
Author(s): James McCoy

Knut Smoczyk showed that expansion of convex hypersurfaces by the reciprocal of the harmonic mean curvature gives rise to a linear second order equation for the evolution of the support function, with corresponding representation formulae for solutions. Here we consider related gradient flows for a class of higher order curvature functionals that give rise to higher order linear parabolic equations for which similar representation formulae for solutions may be obtained. With suitable restrictions on the initial convex hypersurface, solutions exist for all time and converge exponentially fast in the smooth topology to spheres. We also consider evolution by similar flows that keep certain integrals fixed and those that evolve one convex hypersurface to another. Time permitting, we will mention some additional new second order results.

Meyer, Jahne. Evolving polygons via semi-discrete polyharmonic geometric flows
Speaker: Jahne Meyer (The University of Newcastle)
Time: 13:30 Wed 6 December
Place(s): 08-212
Author(s): Jahne Meyer

Motivated by higher order polyharmonic evolution equations on smooth curves, this talk presents comparable semi-discrete geometric flows that evolve and continuously untangle complicated closed polygons. Such polygons can be planar or exist in higher co-dimensions. Solutions can be written down explicitly and behaviour of these deforming polygons explored. As an application, a semi-discrete setting can be given to evolve any closed polygon to another via these geometric flows.

Olanipekun, Peter Olamide. A Rigidity Result for Four Dimensional Willmore-type Submanifolds
Speaker: Peter Olamide Olanipekun (The University of Auckland)
Time: 15:00 Wed 6 December
Place(s): 08-212
Author(s): Peter Olamide Olanipekun

Higher Willmore energies are relatively new in literature. In this talk, I will discuss a rigidity result for the critical points of a four dimensional conformally invariant Willmore-type energy. These critical points satisfy a 4-Willmore equation which is a sixth order nonlinear elliptic partial differential equation.

Poggesi, Giorgio. Soap bubbles and convex cones
Speaker: Giorgio Poggesi (The University of Western Australia)
Time: 14:00 Fri 8 December
Place(s): 08-212
Author(s): Giorgio Poggesi

We consider Alexandrov-type symmetry results and Heintze-Karcher-type inequalities and provide new approaches leading to several benefits and generalizations.

Stanfield, James. Pluriclosed Metrics with Negative Holomorphic Sectional Curvature
Speaker: James Stanfield (The University of Queensland)
Time: 16:30 Tue 5 December
Place(s): 08-212
Author(s): James Stanfield

A compact complex manifold X is called *hyperbolic* if every holomorphic map $\mathbb{C} \to X$ is constant. A long-standing folklore conjecture attributed to Kobayashi predicts that all such manifolds admit a Kähler–Einstein metric with negative scalar curvature and in particular, embed into $\mathbb{CP}^n$. A strictly weaker diffeo-geometric version of the conjecture states that Hermitian manifolds with negative holomorphic sectional curvature should satisfy the same conclusion. In this talk, I will present some recent progress on this conjecture for pluriclosed manifolds, and the key technical ingredient in the proof: an improved Schwarz lemma for Hermitian metrics. This is based on joint work with Kyle Broder.

Thompson, Adam. Ricci solitons with non-compact symmetry
Speaker: Adam Thompson (The University of Queensland)
Time: 17:00 Tue 5 December
Place(s): 08-212
Author(s): Adam Thompson

There are many examples of Ricci solitons that are constructed using the following ansatz: the soliton admits a cohomogeneity one group action by a compact Lie group. On the other hand, there are very few examples of cohomogeneity one Ricci solitons where the group acting is non-compact. We will discuss our construction of new examples of complete cohomogeneity one gradient Ricci solitons where the group action is by a non-compact solvable Lie group.

Wheeler, Glen Edward. Using an ODE to prove the parametrised isoperimetric inequality
Speaker: Glen Edward Wheeler (University of Wollongong)
Time: 15:00 Thu 7 December
Place(s): 08-212
Author(s): Glen Edward Wheeler

In this talk we discuss the use of a penalised Sobolev gradient flow to establish the parametrised isoperimetric inequality. This is a relatively new generalisation of the isoperimetric inequality for immersions that has the correct constant for multiply-covered circles. The result is joint work with Shinya Okabe, Philip Schrader, and Valentina Wheeler.

10. Algebra and Combinatorics

Barton, Samuel. A new classification model based on a population of hypergraphs
Speaker: Samuel Barton (The University of Queensland)
Time: 17:00 Tue 5 December
Place(s): 01-E302
Author(s): Samuel Barton

This talk introduces a novel hypergraph classification algorithm. In previous work, hypergraph models are typically constructed using distance or attribute based methods. That is, hyperedges are generated by connecting a set of samples which are within a certain distance or have a common attribute. These methods however, focus on the main effects of the data and often ignore the multi-way interactions. The algorithm provided in this talk looks to address this problem by constructing hypergraphs which explore multi-way interactions. We also increase the performance and robustness of the algorithm by using a population of hypergraphs. The algorithm is evaluated on two datasets, demonstrating promising performance, compared to a generic benchmark classification algorithm.

Bunjamin, Yudhistira Andersen. Using 4-GDDs to construct 3-GDDs
Speaker: Yudhistira Andersen Bunjamin (UNSW Sydney)
Time: 15:00 Wed 6 December
Place(s): 01-E302
Author(s): Yudhistira A. Bunjamin, Oden Petersen

A k-GDD, or group divisible design with block size k, is a triple (X, G, B) where X is a set of points, G is a partition of X into subsets (called groups) and 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. There are a number of known necessary conditions for the existence of a GDD. However, these conditions are not sufficient.
Recently, some advancements have been made regarding the existence of 4-GDDs with two group sizes. Using a method of recursively constructing GDDs commonly known as Wilson's fundamental GDD construction, these 4-GDDs can be used to construct some infinite families of 3-GDDs with two group sizes. This talk aims to demonstrate how some families of 4-GDDs have been used to help completely determine the existence of 3-GDDs with two group sizes where one of the group sizes is 6 and the other group size is some multiple of 6.

Chebolu, Sunil. The Resonance Hyperplane Arrangement
Speaker: Sunil Chebolu (Illinois State University)
Time: 15:00 Thu 7 December
Place(s): 01-E302
Author(s): Sunil Chebolu and Papa Sissokho

In joint work with Papa Sissokho, we addressed the problem of counting the number of points in the complement of the complete (resonance) hyperplane arrangement over the ring of integers mod n. This problem is considered intractable, and our recent work on this problem has led to several interesting connections to other mathematical problems, including the Hadamard problem, zero-sum free sequences, classifying Mathieu-Zhao subspaces, and the distribution of the values of the Euler-phi function. I will present an overview of this research.

Elder, Murray. On the complexity of epimorphism testing with virtually abelian targets
Speaker: Murray Elder (University of Technology Sydney)
Time: 15:00 Tue 5 December
Place(s): 01-E302
Author(s): Murray Elder, Jerry Shen and Armin Weiß

Friedl and Löh (2021, Confl. Math.) prove that testing whether or not there is an epimorphism from an arbitrary group given by a finite presentation to a virtually cyclic group, or to a product of an abelian group and a finite group, is decidable. We prove that the problem is NP-complete when the target is a virtually cyclic group or semidirect product of a finite rank free abelian group with a finite group acting by $x \to \pm x$ (which includes the $\mathbb{Z}^d \times$ finite groups).

Fresacher, Matthias. Congruence Lattices of Finite Twisted Brauer Monoids
Speaker: Matthias Fresacher (Western Sydney University)
Time: 16:30 Tue 5 December
Place(s): 01-E302
Author(s): Matthias Fresacher

In 2022, East and Ruškuc published the congruence lattice of the infinite twisted partition monoid. As a by product, they established the congruence lattices of the finite d-twisted partition monoids. This talk is a first step in adapting the work of East and Ruškuc to the setting of the Brauer monoid. Specifically, it presents the newly established congruence lattice of the 0-twisted Brauer monoid. With simple to grasp visual multiplication and applications in theoretical physics and representation theory, the family of partition monoids are of particular interest to a number of fields as well are of stand alone interest.

Ghafari Baghestani, Afsane. Construction of Latin squares with restricted transversals
Speaker: Afsane Ghafari Baghestani (Monash University)
Time: 16:30 Wed 6 December
Place(s): 01-E302
Author(s): Afsane Ghafari, Ian Wanless

We prove that there exists an infinite family of Latin Squares of even order with at least one transversal, yet all transversals coincide on some fixed entries. Moreover, we show that the number of these fixed entries will increase as the order of the Latin Square grows.

Gorazd, Roman. Higman Thompson groups and Leavitt path algebras of graphs
Speaker: Roman Gorazd (The University of Newcastle)
Time: 16:00 Tue 5 December
Place(s): 01-E302
Author(s): Roman Gorazd

In this talk I will be talking about the isomorphism problem of Higman-Thompson groups of universal covers of rooted directed graphs and how to achieve a partial condition on when two Higman-Thompson groups are isomorphic by embedding them into the Leavitt path algebras. Furthermore we will look at a special case of this results showing how to reduce a graph while preserving the Higman-Thompson group of it's universal cover.
We will also look at the action of the Higman-Thompson group of the universal cover of a graph and how it's connectivity determines the transitivity of this action

Jackson, Marcel. Some finite model theoretic considerations in algebra
Speaker: Marcel Jackson (La Trobe University)
Time: 14:30 Thu 7 December
Place(s): 01-E302
Author(s): Marcel Jackson

Many of the basic tools and theorems of classical model theory fail completely when restricted to finite structures. Investigations of such collapses have almost uniformly focussed on relational structures, which arise from computer science connections through areas like database theory. The corresponding development on the algebraic side remains almost completely neglected, despite a number of similar algebraic connections, including for example the Eilenberg-Schützenberger Correspondence relating finite semigroups to regular languages and automata. We present some explorations in this theme for finite algebras, presenting a range of results concerning Ehrenfeucht-Fraïssé games on finite algebras, undecidability of first order definability for pseudovarieties, streamlined proofs of classical theorems at the finite level and an example finite lattice-based algebraic structure whose pseudovariety witnesses the simultaneous failure of several different preservation theorems at the finite level.

Kemp, Tara. Latin hypercubes realizing integer partitions
Speaker: Tara Kemp (The University of Queensland)
Time: 17:00 Wed 6 December
Place(s): 01-E302
Author(s): Diane Donovan, Tara Kemp and James Lefevre

L. Fuchs asked the following question: If n is any positive integer and $n = n_1 + n_2 + \cdots + n_k$ any fixed partition of n, is it possible to find a quasigroup Q of order n which contains subquasigroups $Q_1, Q_2, \ldots, Q_k$ of orders $n_1, n_2, \ldots, n_k$ respectively, whose set theoretical union is Q? Such a quasigroup is equivalent to a latin square of order n with disjoint subsquares of orders $n_1, n_2, \ldots, n_k$, and the existence of these latin squares is a partially solved problem. This problem of realizing a partition in a latin square can be extended to latin cubes with disjoint subcubes of the same orders. In this talk, we will discuss the existence problem for latin cubes and how the problem changes as the number of dimensions increases.

Lawson, Sarah. Tudisco and Higham's Nonlinear Eigenvector Centrality for Hypergraphs and its application to biological processes
Speaker: Sarah Lawson (The University of Queensland)
Time: 14:00 Wed 6 December
Place(s): 01-E302
Author(s): Prof. Diane Donovan, Dr James Lefevre and Sarah Lawson

As hypergraphs are increasingly used to model complex networks, researchers are motivated by the need to identify measures to rank the nodes and edges in these structures. Research extending graph eigenvector centrality measures to hypergraphs was initially limited to linear measures for general hypergraphs and nonlinear measures for uniform hypergraphs. In 2021, Tudisco and Higham proposed a nonlinear eigenvector centrality model for ranking nodes and edges in general hypergraphs. In this talk results from a critical analysis of this model are presented and our application of the model to a hypergraph representing real world biological processes is discussed.

Leopardi, Paul Charles. Relations between equivalences of bent functions
Speaker: Paul Charles Leopardi (Australian National University)
Time: 15:00 Fri 8 December
Place(s): 01-E302
Author(s): Paul Leopardi

Consider those bent functions whose value at zero is zero. Two such functions $f, g : \mathbb{F}_2^{2m} \to \mathbb{F}_2$ are said to be

- *General Linear equivalent* if a general linear transformation A exists such that $g(x) = f(Ax)$ for all x in $\mathbb{F}_2^{2m}$,
- *Cayley equivalent* if their Cayley graphs are isomorphic.

The following relationships hold between these two types of equivalence:

(1) General Linear equivalence implies Cayley equivalence,
(2) For quadratic bent functions of this type, Cayley equivalence implies General Linear equivalence,

(3) For cubic and higher degree, two bent functions of this type can be Cayley equivalent but not General Linear equivalent.

This talk outlines proofs of relationships 1. and 2., and gives examples of relationship 3. in 6 dimensions.

Lynch, Sean. Generating functions in algebra, combinatorics and algebraic geometry
Speaker: Sean Lynch (UNSW Sydney)
Time: 14:30 Fri 8 December
Place(s): 01-E302
Author(s): Sean B. Lynch

In 1977, Louis Solomon introduced his namesake zeta function of a module. We give examples of Solomon zeta functions, which are intimately related to other generating functions in algebra, combinatorics and algebraic geometry. We end with a general infinite product formula for semilocal Solomon zeta functions that further these intimate relations.

Maenhaut, Barbara. A Family of Connected 1-Factorisations of Complete 3-Uniform Hypergraphs
Speaker: Barbara Maenhaut (The University of Queensland)
Time: 14:30 Wed 6 December
Place(s): 01-E302
Author(s): Barbara Maenhaut, Jeremy Mitchell, Anna Puskas

A connected 1-factorisation is a 1-factorisation of a hypergraph for which the union of each pair of distinct 1-factors is a connected hypergraph. A uniform 1-factorisation is a 1-factorisation of a hypergraph for which the union of each pair of distinct 1-factors is isomorphic to the same subhypergraph, and a uniform-connected 1-factorisation is a uniform 1-factorisation in which that subhypergraph is connected. These notions are natural generalisations of perfect 1-factorisations of graphs. In a 2017 paper, Chen and Lu described a family of 1-factorisations of the complete 3-uniform hypergraph on $q+1$ vertices, where $q \equiv 2 \pmod 3$ is a prime power. In this talk, we will determine when these 1-factorisations are connected and/or uniform.

Morgan, Kerri. Certificates of Splitting Field Equivalence for the Chromatic Polynomial
Speaker: Kerri Morgan (Royal Melbourne Institute of Technology)
Time: 14:00 Thu 7 December
Place(s): 01-E302
Author(s): Kerri Morgan

The chromatic polynomial $P(G;\lambda)$ of a graph G gives the number of proper colourings of a graph. The roots of the chromatic polynomial (chromatic roots) have been widely studied. The family of chordal graphs have only integer chromatic roots. However, there exist non-chordal graphs that have only integer chromatic roots. For example, Read (1975) identified a non-chordal graph of order seven. The real non-integer chromatic roots lie in the interval $\left[\frac{32}{7}, 1\right)$ (Jackson (1993), Thomassen (1997)) and the complex chromatic roots are dense in the complex plane (Sokal (2004)).
In this talk, we consider chromatic polynomials with the same splitting field. Chordal graphs have the trivial splitting field. We consider some graph operations that preserve splitting field equivalence. We introduce the notion of a certificate of splitting field equivalence, that is, a sequence of algebraic transformations based on identities for the chromatic polynomial that can be used to show two graphs have chromatic polynomials with the same splitting field.
Joint work with Peter Cameron and Graham Farr

Piggott, Adam. Quasi-transitive geodetic graphs Part I
Speaker: Adam Piggott (Australian National University)
Time: 14:00 Tue 5 December
Place(s): 01-E302
Author(s): Murray Elder, Giles Gardam, Adam Piggott, Davide Spriano and Kane Townsend.

In the 1960s, Ore initiated a program to classify all geodetic graphs; in the 1980s, Madlener and Otto conjectured that the groups presented by finite confluent length-reducing rewriting systems are exactly the plain groups; in the 1990s Shapiro asked if the groups that admit geodetic Cayley graphs are exactly the plain groups. All three programs of research are ongoing. In this talk we explain the relationship between these programs of research and introduce the tools that helped us make significant progress on each in a recent collaboration with Murray Elder, Giles Gardam, Davide Spriano and Kane Townsend.

Ricci Pinheiro, Marcia. Equal Probability for the Monty Hall Problemś Options
Speaker: Marcia Ricci Pinheiro (None)
Time: 14:00 Fri 8 December
Place(s): 01-E302
Author(s): Marcia Ricci Pinheiro

In this paper, we present the complete tables resulting from the mathematical analysis of The Monty Hall Problem and discuss a solution presented by a professor who got a PhD from the Aarhus University. The results are that there is a flaw in the reasoning used by the professor and the Monty Hall Problem has been associated with a lot of mistaken mathematical analysis: Switching and sticking, the final choice in the game that generates the problem, return the same probability in what regards winning or losing. When the game became a mathematical problem, 10,000 readers expressed their certainty that this was the case.

Townsend, Kane. Quasi-transitive geodetic graphs Part II
Speaker: Kane Townsend (University of Technology Sydney)
Time: 14:30 Tue 5 December
Place(s): 01-E302
Author(s): Murray Elder, Giles Gardam, Adam Piggott, Davide Spriano and Kane Townsend

A graph is *geodetic* if there is a unique geodesic between each pair of vertices. In this talk we prove that quasi-transitive geodetic graphs are quasi-isometric to a tree. This constitutes significant progress in characterising the groups that admit geodetic Cayley graphs, in particular showing such groups are presentable by inverse-closed finite confluent length-reducing rewriting systems. The key structure that appears in our proof combines elements of the *geodesic boundary* of a geodetic graph and *isometrically embedded circuits* in a novel way.
This is joint work with Murray Elder, Giles Gardam, Adam Piggott and Davide Spriano.

Willis, George. Scale groups
Speaker: George Willis (The University of Newcastle)
Time: 13:30 Tue 5 December
Place(s): 01-E302
Author(s): George Willis

A scale group is a closed subgroup of the automorphism group of a regular tree which fixes an end of the tree and is transitive on vertices. General totally disconnected, locally compact groups typically have many scale group sub-quotients, and so an understanding these concrete groups contributes to the understanding of the abstract groups. Scale groups also correspond to self-replicating groups acting on rooted trees, which are of independent interest and the subject of much research in their own right. These roles of scale groups will be explained in the talk and progress towards a description of all scale groups will be outlined.

Zhang, Chuanqi. On linear-algebraic notions of expansion
Speaker: Chuanqi Zhang (University of Technology Sydney)
Time: 16:00 Wed 6 December
Place(s): 01-E302
Author(s): Yinan Li, Youming Qiao, Avi Wigderson, Yuval Wigderson, Chuanqi Zhang

A fundamental fact about bounded-degree graph expanders is that three notions of expansion—vertex expansion, edge expansion, and spectral expansion—are all equivalent. This motivates us to study to what extent such a statement is true for linear-algebraic notions of expansion.
There are two well-studied notions of linear-algebraic expansion, namely dimension expansion [1] (defined in analogy to graph vertex expansion) and quantum expansion [2, 3] (defined in analogy to graph spectral expansion). Lubotzky and Zelmanov [4] proved that the latter implies the former. We proved that the converse is false: there are dimension expanders which are not quantum expanders.
Moreover, this asymmetry is explained by the fact that there are two distinct linear-algebraic analogues of graph edge expansion. The first of these is *quantum edge expansion*, which was introduced by Hastings [5], and which he proved to be equivalent to quantum expansion. We established a new notion, termed *dimension edge expansion*, which we proved is equivalent to dimension expansion and which is implied by quantum edge expansion. Thus, the separation above is implied by a finer one: dimension edge expansion is strictly weaker than quantum edge expansion. This new notion also led to a new and more modular proof of the Lubotzky-Zelmanov result [4] that quantum expanders are dimension expanders.

[1] Boaz Barak, Russell Impagliazzo, Amir Shpilka, and Avi Wigderson. Definition and existence of dimension expanders. Discussion (no written record), 2004.
[2] Avraham Ben-Aroya and Amnon Ta-Shma. Quantum expanders and the quantum entropy difference problem. ArXiv:quant-ph/0702129, 2007.
[3] M. B. Hastings. Entropy and entanglement in quantum ground states. *Phys. Rev. B*, 76:035114, Jul 2007.
[4] Alexander Lubotzky and Efim Zelmanov. Dimension expanders. *Journal of Algebra*, 319(2):730–738, 2008.
[5] M. B. Hastings. Random unitaries give quantum expanders. *Physical Review A*, 76:032315, Sep 2007.

Zhang, Erchuan. Antiregular k-hypergraph and independent polynomial
Speaker: Erchuan Zhang (Edith Cowan University)
Time: 13:30 Wed 6 December
Place(s): 01-E302
Author(s): Erchuan Zhang

Given an integer $k \geq 3$ and initial $k-1$ isolated vertices, an *antiregular k-hypergraph* is constructed by alternatively adding an isolated vertex (connected to no other vertices) or a dominating vertex (connected to every other $k-1$ vertices). Let a_i be the number of independent sets of cardinality i in a hypergraph H, then the *independence polynomial* of H is defined as $I(H;x) = \sum_{i=0}^{m} a_i x^i$, where m is the size of a maximum independent set. In this talk, we will discuss some properties of the independence polynomial of an antiregular k-hypergraph, in particular, the log-concavity property.

11. Harmonic Analysis

Bui, Anh. On Hermite pseudo–multipliers revisited
Speaker: Anh Bui (Macquarie University)
Time: 14:30 Wed 6 December
Place(s): 08-257
Author(s): The Anh Bui

We will consider sufficient conditions for Hermite pseudo-multipliers to be bounded on various function spaces such as the weighted/unweighted Lebesgue spaces, Hardy-type spaces and BMO-type spaces. The talk is based on joint work with Xuan Duong and Fu Ken Ly.

Chen, Zijun. Local well-posedness for dispersion generalized Benjamin-Ono equations in Fourier-Lebesgue spaces
Speaker: Zijun Chen (Monash University)
Time: 15:00 Wed 6 December
Place(s): 08-257
Author(s): Zijun Chen, Zihua Guo

We consider the Cauchy problem for the dispersion generalized Benjamin-Ono equation in the Fourier-Lebesgue space $\mathcal{F}L^{s,r}(\mathbb{R})$. Assume that $0 \leq \alpha \leq 1$ and $1 \leq r \leq \alpha + 1$. The Cauchy problem is locally well-posed in $\mathcal{F}L^{s,r}(\mathbb{R})$ if $s \geq max\left\{1 - \frac{\alpha+1}{r}, -\alpha - 1 + \frac{1}{r} + \frac{\alpha+2}{r^2}\right\}$.

Guo, Zihua. Uniform estimates for oscillatory integrals with parameter-dependent phases
Speaker: Zihua Guo (Monash University)
Time: 14:00 Wed 6 December
Place(s): 08-257
Author(s): Zihua Guo

We consider the oscillatory integrals with parameter-dependent phases. We track clearly the dependence of the phases in the asymptotic estimates of the oscillatory integrals and hence can obtain some uniform estimates when the phases satisfy certain conditions. Some applications will also be given.

Hauer, Daniel. Bernstein functional calculus and a generalized Helmholtz problem
Speaker: Daniel Hauer (The University of Sydney)
Time: 14:30 Fri 8 December
Place(s): 08-257
Author(s): Robert Denk (University of Konstanz, Germany), Daniel Hauer (University of Sydney), and David Lee (Laboratoire Jacques-Louis Lions, Paris, France).

In this talk, I aim to characterize all distributional solutions of the generalized Helmholtz equation

$$f(-\Delta)u = f(k^2)u \qquad \text{on the Euclidean space } \mathbb{R}^d$$

for every real $k \neq 0$ and non-constant Bernstein function f. To attack this problem, we first need to introduce a notion of *distributional* solutions of the generalized Helmholtz equation. This involves showing that the negative Laplacian is non-negative on a Lizorkin space.

The results presented in this talk are obtained in joint work with Robert Denk (University of Konstanz, Germany) and David Lee (Laboratoire Jacques-Louis Lions, Paris, France).

Hogan, Jeffrey. Clifford translations, splines and bandpass bases
Speaker: Jeffrey Hogan (The University of Newcastle)
Time: 14:30 Tue 5 December
Place(s): 08-212
Author(s): Jeffrey Hogan

Motivated by difficulties in extending one-dimensional constructions of splines to higher dimensions, we consider Clifford generalisations of the classical translation and modulation operators of multi-dimensional harmonic analysis. Unlike the classical operators, their Clifford counterparts act isotropically. In odd dimensions, Clifford modulation maps bandlimited functions (whose Fourier transforms are supported on balls) to bandpass functions (whose Fourier transforms are supported on annuli) - like classical one-dimensional modulations. This leads to a construction of Clifford splines, and a means of transferring orthonormal bases for Paley-Wiener spaces associated with balls to orthonormal bases for Paley-Wiener spaces associated with annuli.

Hu, Bingyang. On the curved trilinear Hilbert transform
Speaker: Bingyang Hu (None)
Time: 14:00 Fri 8 December
Place(s): 08-257
Author(s): Bingyang Hu and Victor Lie

The goal of this talk is to discuss the Lp boundedness of the trilinear Hilbert transform along the moment curve. More precisely, we show that the operator

$$H_C(f_1, f_2, f_3)(x) := p.v. \int_{\mathbb{R}} f_1(x-t) f_2(x+t^2) f_3(x+t^3) \frac{dt}{t}, \quad x \in \mathbb{R}$$

is bounded from $L^{p_1}(\mathbb{R}) \times L^{p_2}(\mathbb{R}) \times L^{p_3}(\mathbb{R})$ into $L^r(\mathbb{R})$ within the Banach Hölder range $\frac{1}{p_1} + \frac{1}{p_2} + \frac{1}{p_3} = \frac{1}{r}$ with $1 < p_1, p_3 < \infty$, $1 < p_2 \leq \infty$ and $1 \leq r < \infty$.
The main difficulty in approaching this problem(compared to the classical approach to the bilinear Hilbert transform) is the lack of absolute summability after we apply the time-frequency discretization(which is known as the LGC methodology introduced by V. Lie in 2019). To overcome such a difficulty, we develop a new, versatile approach – referred to as Rank II LGC (which is also motived by the study of the non-resonant bilinear Hilbert-Carleson operator by C. Benea, F. Bernicot, V. Lie, and V. Vitturi in 2022), whose control is achieved via the following interdependent elements:
1). a sparse-uniform decomposition of the input functions adapted to an appropriate time-frequency foliation of the phase-space;
2). a structural analysis of suitable maximal "joint Fourier coefficients";
3). A level set analysis with respect to the time-frequency correlation set.
This is a joint work with my postdoc advisor Victor Lie from Purdue.

Lee, Sanghyuk. L^p bounds on the strong spherical maximal functions
Speaker: Sanghyuk Lee (Seoul National University)
Time: 13:30 Tue 5 December
Place(s): 08-212
Author(s): Sanghyuk Lee

This talk concerns L^p bounds on the strong spherical maximal functions that are multi-parametric maximal functions defined by averages over ellipsoids. We obtain L^p bounds on those maximal operators for a certain nontrivial range of p. No such maximal bounds have been not known until recently. Our results extend Stein's celebrated spherical maximal bounds to multi-parametric versions. This talk is based on joint work with Joyoung Lee and Sewook Oh.

Li, Ji. Some recent progress on analysis on model domains
Speaker: Ji Li (Macquarie University)
Time: 14:00 Tue 5 December
Place(s): 08-212
Author(s): Ji Li

We consider the polynomial model domain on C2, where there is no group structure. We lift these domains to stratified Lie groups via a constructive proof, which optimizes the well-known lifting procedure to free Lie groups of general manifolds defined by Rothschild and Stein. This yields an explicit version of the Taylor expansion with respect to the horizontal vector fields induced by the sub-Riemannian structure on these hypersurfaces. Hence there are some further applications.

Ly, Fu Ken. Higher order Riesz transforms and almost diagonality for Hermite expansions
Speaker: Fu Ken Ly (The University of Sydney)
Time: 15:00 Tue 5 December
Place(s): 08-212
Author(s): Fu Ken Ly

We will discuss some known results for the Riesz transforms associated to the Hermite operator $-\Delta + |x|^2$ on various function spaces, and then show how Frazier and Jawerth's classical theory of almost diagonal operators can be used to establish the boundedness of Hermite Riesz Transforms of all orders on the Besov and Triebel–Lizorkin scale. This addresses an open problem in the literature and is based on joint work with The Anh Bui.

Sikora, Adam. Hardy spaces meet harmonic weights revisited
Speaker: Adam Sikora (Macquarie University)
Time: 13:30 Fri 8 December
Place(s): 08-257
Author(s): Marcin Preisner, Adam Sikora

We investigate Hardy spaces $H^1_L(X)$ corresponding to self-adjoint operators L. Our main aim is to obtain a description of $H^1_L(X)$ in terms of atomic decompositions similar to such characterisation of the classical Hardy spaces $H^1(\mathbb{R}^d)$. Under suitable assumptions, such a description was obtained by Yan and the authors in [Trans. Amer. Math. Soc. 375 (2022), no. 9, 6417-6451], where the atoms associated with an L-harmonic function are considered. Here we continue this study and modify the previous definition of atoms.
The modified approach allows us to investigate settings, when the generating operator is related to a system of linearly independent harmonic functions. In this context, the cancellation condition for atoms is adjusted to fit this system. In an explicit example, we consider a symmetric manifold with ends $\mathbb{R}^d \# \mathbb{R}^d$. For this manifold the space of bounded harmonic functions is two-dimensional. Any element from the Hardy space $H^1_L(X)$ has to be orthogonal to all of the harmonic functions in the system.

Sundaram, Thangavelu. On the range of Poisson transform on noncompact Riemannian symmetric spaces
Speaker: Thangavelu Sundaram (Indian Institute of Science Bangalore)
Time: 13:30 Wed 6 December
Place(s): 08-257
Author(s): Heiko Gimperlein, Bernhard Kroetz, Luz Roncal and Sundaram Thangavelu

We consider the Poisson transform P_λ on a noncompact Riemannian symmetric space $X = G/K$ which takes functions $f \in L^2(N)$ into eigenfunctions of the Laplace-Beltrami operator on X. Here $G = NAK$ is the Iwasawa decomposition of the semi simple Lie group G. For any $a \in A$ it is known that $\varphi_a(n) = P_\lambda f(na)$ extends holomorphically to a tube domain in the complexification of N. We show that the image of $L^2(N)$ under the Poisson transform can be characterised as a weighted Bergman space. This talk is based on joint work with Gimperlein, Kroetz and Roncal.

12. Modern Techniques in Financial Mathematics

Chen, Chang. Mean-bPOE Portfolio Optimization
Speaker: Chang Chen (The University of Queensland)
Time: 15:00 Wed 6 December
Place(s): 03-314
Author(s): Chang Chen, Duy-Minh Dang

With buffered probability of exceedance (bPOE) as risk measure, we propose mean-bPOE optimization framework. Mathematically, bPOE is a kind of inverse function of conditional value at risk (CVaR). Instead of returning average loss given certain probability (confidence level), bPOE returns probability given average worst loss. In the context of optimization, shifting risk measure from CVaR to bPOE translating interpretation of constraint from abstract probability to intuitive monetary difference. Thus, from explanatory perspective, bPOE is a much more informative indicator measuring downside risk, especially for ordinary individuals who have not received professional investment education. We also compare the control results from mean-bPOE with that of mean-CVaR, present some discussion and analysis.

Chen, Yuyu. An unexpected stochastic dominance: Pareto distributions, catastrophes, and risk exchange
Speaker: Yuyu Chen (The University of Melbourne)
Time: 14:00 Thu 7 December
Place(s): 03-314
Author(s): Yuyu Chen, Paul Embrechts, Ruodu Wang

We show the perhaps surprising inequality that the weighted average of negatively dependent super-Pareto random variables, possibly caused by triggering events, is larger than one such random variable in the sense of first-order stochastic dominance. The class of super-Pareto distributions is extremely heavy-tailed and it includes the class of infinite-mean Pareto distributions. We discuss several implications of this result via an equilibrium analysis in a risk exchange market. First, diversification of super-Pareto losses increases portfolio risk, and thus a diversification penalty exists. Second, agents with super-Pareto losses will not share risks in a market equilibrium. Third, transferring losses from agents bearing super-Pareto losses to external parties without any losses may arrive at an equilibrium which benefits every party involved. The empirical studies show that our new inequality can be observed empirically for real datasets that fit well with extremely heavy tails.

Dang, Duy-Minh. Fourier Neural Network Approximation of Transition Densities in Finance
Speaker: Duy-Minh Dang (The University of Queensland)
Time: 15:00 Fri 8 December
Place(s): 03-314
Author(s): Rong Du, Duy-Minh Dang

This paper introduces FourNet, a novel single-layer feed-forward neural network (FFNN) method designed to approximate transition densities for which closed-form expressions of their Fourier transforms, i.e. characteristic functions, are available. A unique feature of FourNet lies in its use of a Gaussian activation function, enabling exact Fourier and inverse Fourier transformations and drawing analogies with the Gaussian mixture model. We mathematically establish FourNet's capacity to approximate transition densities in the L_2-sense arbitrarily well with finite number of neurons. The parameters of FourNet are learned by minimizing a loss function derived from the known characteristic function and the Fourier transform of the FFNN, complemented by a strategic sampling approach to enhance training. Through a rigorous and comprehensive error analysis, we derive informative bounds for the L_2 estimation error and the potential (pointwise) loss of nonnegativity in the estimated densities. FourNet's accuracy and versatility are demonstrated through a wide range of dynamics common in quantitative finance, including Lévy processes and the Heston stochastic volatility models-including those augmented with the self-exciting Queue-Hawkes jump process.

Das, Kaustav. On Stochastic Partial Differential Equations and their applications to Derivative Pricing through a conditional Feynman-Kac formula
Speaker: Kaustav Das (Monash University)
Time: 15:00 Thu 7 December
Place(s): 03-314
Author(s): Kaustav Das, Ivan Guo, Gregoire Loeper

In a multi-dimensional diffusion framework, the price of a financial derivative can be expressed as an iterated conditional expectation, where the inner conditional expectation conditions on the future of an auxiliary process (usually volatility/variance) that enters into the dynamics for the spot. Inspired by results from non-linear filtering theory, we show that this inner conditional expectation solves a backward SPDE (a so-called 'conditional Feynman-Kac formula'), thereby establishing a connection between SPDE and derivative pricing theory. Through the conditional Feynman-Kac formula, we establish an alternative class of so-called mixed Monte-Carlo PDE numerical methods for pricing financial derivatives. We provide a simple demonstration of this method by pricing a European put option.

Guo, Ivan. An Efficient Frontier of Wealth Distributions with Connections to Utility Maximisation
Speaker: Ivan Guo (Monash University)
Time: 13:30 Thu 7 December
Place(s): 03-314
Author(s): Ivan Guo, Kihun Nam, Erik Schlogl

In this talk, we extend the notion of efficient portfolios to efficient wealth distributions. These correspond to portfolios that are not first/second-order stochastically dominated by other portfolios. Under general model-agnostic settings, we use classical results in optimal transport to explicitly characterise the set of efficient wealth distributions and their optimal portfolios. Moreover, by studying the dual formulation, we form a correspondence between this efficient frontier and utility maximisation problems, and show that every such efficient wealth distribution is the maximiser of a concave utility function. Various extensions to non-linear settings will also be discussed.

Jeon, Haejun. Time-to-build, regulation, and investment
Speaker: Haejun Jeon (Tokyo University of Science)
Time: 14:30 Fri 8 December
Place(s): 03-314
Author(s): Haejun Jeon

This study investigates the effects of uncertainty in time-to-build and regulation, which hinders immediate revenue generation after investment, on a firm's optimal investment decision. We show that in the absence of regulation, uncertainty in time-to-build always accelerates investment and enhances firm value. We also show that in the absence of time-to-build, uncertainty in regulation can mitigate the distortion of investment induced by regulation. Furthermore, we show that in the presence of both time-to-build and regulation, there can exist harmless regulation that does not induce any distortion in the investment decision nor does it harm firm value. Lastly, we show that in the presence of both time-to-build and regulation, not only uncertainty in time-to-build but also its presence can accelerate investment.

Li, Libo. Vulnerable European and American Options in a Market Model with Optional Hazard Process
Speaker: Libo Li (University of New South Wales)
Time: 14:00 Wed 6 December
Place(s): 03-314
Author(s): Libo Li, Ruyi Liu and Marek Rutkowski

We study the upper and lower bounds for prices of European and American style options with the possibility of an external termination, meaning that the contract may be terminated at some random time. Under the assumption that the underlying market model is incomplete and frictionless, we obtain duality results linking the upper price of a vulnerable European option with the price of an American option whose exercise times are constrained to times at which the external termination can happen with a non-zero probability. Similarly, the upper and lower prices for an vulnerable American option are linked to the price of an American option and a game option, respectively. In particular, the minimizer of the game option is only allowed to stop at times which the external termination may occur with a non-zero probability.

Lu, Yaowen. A semi-Lagrangian ε-monotone Fourier method for continuous withdrawal GMWBs under jump-diffusion with stochastic interest rate
Speaker: Yaowen Lu (None)
Time: 16:30 Wed 6 December
Place(s): 03-314
Author(s): Yaowen Lu, Duy-Minh Dang

We develop an efficient pricing approach for guaranteed minimum withdrawal benefits (GMWBs) that involve continuous withdrawals under a realistic modeling setting with jump diffusions and stochastic interest rates. Using an impulse stochastic control framework, we formulate the no-arbitrage GMWB pricing problem as a time-dependent Hamilton-Jacobi-Bellman (HJB) Quasi-Variational Inequality (QVI) with three spatial dimensions having cross-derivative terms. We develop a numerical approach by combining a semi-Lagrangian method and Green's function of an associated linear partial integro-differential equation. This approach leads us to the development of an ε-monotone Fourier pricing method. Together with a provable strong comparison result for the HJB-QVI, we mathematically demonstrate the convergence of the proposed scheme to the viscosity solution of the HJB-QVI as $\varepsilon \to 0$. We present a study of the impact of considering jumps in the sub-account process and stochastic interest rate on the no-arbitrage prices and fair insurance fees of GMWBs and on the holder's optimal withdrawal behaviors. This is a joint work with Dr. Duy-Minh Dang.
The paper DOI 10.1002/NUM.23075.

Nakatsu, Tomonori. Computation of the Greeks of barrier options
Speaker: Tomonori Nakatsu (Shibaura Institute of Technology)
Time: 14:30 Thu 7 December
Place(s): 03-314
Author(s): Tomonori Nakatsu

In this talk, we shall consider the computation of the Greeks of barrier options. In particular, we will give extensions of the results obtained in Gobet and Kohatsu-Higa [1] and Nakatsu [2]. If time permits, some numerical results will also be given.

References

[1] Gobet, E., Kohatsu-Higa, A.: Computation of greeks for barrier and look-back options using Malliavin calculus. Electron. Commun. Probab. **8**, 51-62 (2003).
[2] Nakatsu, T.: Volatility risk structure for options depending on extrema. J. Comput. Finance, **21**(3), 105–122 (2017).

Xu, Yunxi. Strong solutions of mean-field FBSDEs with measurable coefficients and their applications to multi-population mean-field game
Speaker: Yunxi Xu (Monash University)
Time: 16:00 Wed 6 December
Place(s): 03-314
Author(s): Yunxi Xu

We study the existence of strong solutions for mean-field forward-backward stochastic differential equations (FBSDEs) with measurable coefficients and their implication on the Nash equilibrium of a multi-population mean-field game. More specifically, we allow the coefficients to be discontinuous in the forward process and non-Lipschitz continuous concerning its time-sectional distribution. Using the Pontryagin stochastic maximum principle, we apply our existence result to a multi-population mean-field game (MPMFG) model where the interacting agents in the system are grouped into multiple populations. Each population shares the same objective function, and individual agents may migrate to another population.

Zhou, Hao. Monotone piecewise constant control integration schemes for the two-factor uncertain volatility model
Speaker: Hao Zhou (The University of Queensland)
Time: 17:00 Wed 6 December
Place(s): 03-314
Author(s): Hao Zhou and Duy-Minh Dang

Option contracts written on two underlying assets that follow an uncertain volatility model have their worst-case and best-case prices determined by solution to a two-dimensional Hamilton-Jacobi-Bellman (HJB) partial differential equation (PDE). Existing numerical techniques for multi-dimensional HJB PDEs primarily utilize finite differences and policy iteration to solve the resulting non-linear algebraic

equations at each timestep. This paradigm demands a rather complex local coordinate rotation of computational stencils for a monotonicity-preserving approximation of cross derivative terms.
This paper presents a novel and more streamlined approach to tackle the aforementioned HJB PDE. Within each timestep, our strategy employs a piecewise constant control, breaking down the HJB PDE into independent linear two-dimensional PDEs. Using known closed-form expressions for the Fourier transforms of the Green's functions associated with these PDEs, we determine an explicit formula for these functions. Since the Green's functions are non-negative, the solutions to the PDEs, cast as two-dimensional convolution integrals, can be conveniently approximated using a monotone integration method. Such integration methods, including a composite quadrature rule, are generally available in popular programming languages. To further enhance efficiency, we propose an implementation of this monotone integration scheme via Fast Fourier Transforms, exploiting the Toeplitz matrix structure. Optimal solution/control is subsequently obtained by synthesizing the solutions of the individual PDEs.
The proposed monotone piecewise constant control method is proven to be both ℓ_∞-stable and consistent in the viscosity sense. As a result, it guarantees convergence to the viscosity solution. Numerical results show remarkable agreement with benchmark solutions obtained through monotone finite differences (published test cases) and Monte Carlo simulation, underscoring the effectiveness of our approach.

Zhou, Zhou. Stability of Equilibria in Time-inconsistent Stopping Problems
Speaker: Zhou Zhou (The University of Sydney)
Time: 13:30 Wed 6 December
Place(s): 03-314
Author(s): Erhan Bayraktar, Zhenhua Wang, Zhou Zhou

We investigate the stability of equilibrium-induced optimal values with respect to reward functions f and transition kernels Q for time-inconsistent stopping problems under nonexponential discounting in discrete time. First, with locally uniform convergence of f and Q equipped with total variation distance, we show that the optimal value is semi-continuous with respect to (f, Q). We provide examples showing that continuity may fail in general, and the convergence for Q in total variation cannot be replaced by weak convergence. Next we show that with the uniform convergence of f and Q, the optimal value is continuous with respect to (f, Q) when we consider a relaxed limit over ε-equilibria. We also provide an example showing that for such continuity the uniform convergence of (f, Q) cannot be replaced by locally uniform convergence. We also extend our results to a one-dimensional diffusion setting.

13. Mathematical Physics

Bennett, Lachlan. Occupancy probabilities in superintegrable bosonic networks
Speaker: Lachlan Bennett (The University of Queensland)
Time: 13:30 Tue 5 December
Place(s): 05-213
Author(s): Lachlan Bennett

TBA

Bourgine, Jean-Emile. A (q,t)-deformation of the Toda integrable hierarchy
Speaker: Jean-Emile Bourgine (The University of Melbourne)
Time: 13:30 Fri 8 December
Place(s): 05-213
Author(s): Jean-Emile Bourgine

In this talk, I will present a deformation of the 2d Toda integrable hierarchy inspired by a connection with (refined) topological strings. It is derived by enhancing the underlying $gl(\infty)$ symmetry algebra to the quantum toroidal gl(1) algebra. The difference-differential equations of the deformed hierarchy are obtained from the expansion of (q,t)-bilinear identities, and two equations refining the 2d Toda equation are found in this way. I will also present an interesting class solutions built from the R-matrix of the toroidal algebra.

Celeste, Joshua. The topology of knotted semimetals
Speaker: Joshua Celeste (The University of Adelaide)
Time: 14:00 Tue 5 December
Place(s): 05-213
Author(s): Joshua Celeste

I shall describe an extension to the topological classification scheme of Weyl semimetals via cohomology and the Mayer-Vietoris sequence, to account for higher dimensional submanifolds as opposed to simply points. A particular case of special interest is nodal line semimetals, such as when space-time inversion symmetry occurs. These systems do not exhibit a band gap on a Weyl submanifold consisting of components diffeomorphic to circles, i.e. knots and links. For such systems I shall describe a manifestly topological argument for the mod 2 charge cancellation condition for the monopole charge of nodal lines.

Chen, Ming. Exact solution for Hawking radiation and wave scattering of charged massless scalar field by the charged C-metric black hole
Speaker: Ming Chen (The University of Queensland)
Time: 17:00 Wed 6 December
Place(s): 05-213
Author(s): Ming Chen

We show that the separated radial and angular parts of a charged massless scalar field equation in the C-metric background respectively satisfy the general Heun equations. We analyse wave scattering of the scalar field by C-metric black hole based on exact solutions of the radial Heun equation. Exact behaviours of the asymptotic wave functions in the tortoise coordinates and in terms of connection coefficients are determined without approximations. We apply the exact results to derive Hawking radiation, quasi-normal modes and superradiance. Numerical simulations for quasinormal modes are also presented.

De Gier, Jan. Integrable half space exclusion process and diagonally symmetric alternating sign matrices
Speaker: Jan De Gier (The University of Melbourne)
Time: 17:00 Tue 5 December
Place(s): 05-213
Author(s): Alexandr Garbali, Jan de Gier, William Mead and Michael Wheeler

We discuss a new exact expression for the transition probability of the exclusion process on the semi-infinite half-line with general open boundaries. Intermediate ghost particles imply a non-trivial empty-to-empty transition probability for this model. We discuss an explicit Pfaffian expression for this probability that surprisingly also resolves an outstanding case related to diagonally symmetric alternating sign matrices, not dealt with by Kuperberg.

Desiraju, Harini. Modular transformation of the toric conformal blocks
Speaker: Harini Desiraju (The University of Sydney)
Time: 14:00 Thu 7 December
Place(s): 05-213
Author(s): Harini Desiraju

Through the Painlevé/CFT correspondence, the properties of toric $c = 1$ conformal blocks can be studied through the solutions of the elliptic form of the sixth Painlevé equation for a special choice of parameters, also known as the non-autonomous elliptic Calogero-Moser (NAECM) model, and its generalizations. In this talk, I will derive the connection constant for the equations of motion of the NAECM model and relate it to the modular transformation of the $c = 1$ conformal block on the torus. This talk is based on an upcoming work with Fabrizio Del Monte and Pavlo Gavrylenko.

Gold, Gregory. A Functional Approach to Cosmological Particle Production
Speaker: Gregory Gold (The University of Queensland)
Time: 16:00 Tue 5 December
Place(s): 05-213
Author(s): Gregory Gold

While a complete theory of quantum gravity is still in development, many important physical phenomena have been discovered by approximations to the complete description. Semiclassical gravity for example predicts the creation of quantized matter in time-dependent spacetime backgrounds providing physical insight into cosmological models. Due to the inherent ambiguity of quanta in dynamic

backgrounds, the common approach is to compare globally asymptotic regions by canonical transformations. I discuss instead an alternative approach by functional methods offering an efficient tool with which to calculate particle production in the presence of time dependent background fields via the imaginary part of the one-particle irreducible effective action. In the limit where backreaction can be neglected, closed form, if not exact expressions have been obtained for a variety of time dependent background field dependence including an inflationary background approximated by de Sitter space. In this context, one may show that the standard lore which says violations of a commonly accepted adiabaticity condition necessarily implies particle production on time dependent backgrounds, is a necessary but not sufficient condition for particle production.

Jones, Mitchell. Transfer Matrices of Gaudin superalgebras
Speaker: Mitchell Jones (The University of Queensland)
Time: 14:00 Wed 6 December
Place(s): 05-213
Author(s): Mitchell Jones

Integrable systems with supersymmetric properties can be constructed using representations of superalgebras. We construct Gaudin superalgebras using the general linear gl$(m|n)$ Lie superalgebras and examine their properties. These systems are considered to be Yang-Baxter integrable as a result of their commuting transfer matrices. We find certain constructions expressing the associated transfer matrices as being identically zero. This results in a dilemma as to whether these systems can be regarded as Yang-Baxter integrable. In this talk, I will present our findings on how to remedy this issue. In addition, I will also reveal the process on how to identify when a zero transfer matrix will occur.

Joshi, Nalini. Birational maps through the lens of cryptography
Speaker: Nalini Joshi (The University of Sydney)
Time: 13:30 Thu 7 December
Place(s): 05-213
Author(s): Nalini Joshi

Elliptic curves possess deep mathematical structures, which have led to cryptographic algorithms in a wide range of applications. They rely on the ease of multiplying points on elliptic curves combined with the difficulty of finding their component factors. An algorithm that was considered for implementing public-key cryptography on quantum computers went one step further; it was based on factoring curves, rather than factoring numbers. Elliptic curves also lie at the foundations of a very different theory in mathematical physics: the construction of integrable maps. In this talk, I describe how such integrable maps fit into the framework of elliptic curve cryptography.

Kennedy, Christian. 6D $\mathcal{N} = (2, 0)$ Conformal Supergravity
Speaker: Christian Kennedy (The University of Queensland)
Time: 16:00 Wed 6 December
Place(s): 05-213
Author(s): Christian Kennedy, Lorenzo Casarin, Gabriele Tartaglino-Mazzucchelli

During the last four decades, supersymmetry has been at the forefront of theoretical and mathematical physics of fundamental interactions. It played a crucial role in constructing models aimed at the unification of all forces including quantum gravity, namely string theory. This talk explores a topic closely related to compactifications of string theory: 6D $\mathcal{N} = (2, 0)$ conformal supergravity. A superconformal algebra extension of the conformal algebra does not exist in spacetime dimensions greater than six. The main idea of 6D $\mathcal{N} = (2, 0)$ conformal supergravity is that it gauges the 6D $\mathcal{N} = (2, 0)$ superconformal algebra and makes its symmetries local, introducing interesting supermultiplets of fields as a consequence. Two lines of research are pursued: (1) the construction of the superspace geometry of 6D $\mathcal{N} = (2, 0)$ conformal supergravity, (2) the analysis of the associated 6D $\mathcal{N} = (2, 0)$ conformal anomalies for various fields.

Khandelwal, Saurish. All gauged curvature-squared invariants of mininal (N=1) supergravity in five dimensions
Speaker: Saurish Khandelwal (The University of Queensland)
Time: 15:00 Tue 5 December
Place(s): 05-213
Author(s): Saurish Khandelwal

In the quest to unite quantum mechanics and Einstein's theory of gravity, two leading candidates have emerged: string theory and supersymmetry. String theory introduces quantum corrections as higher-derivative deformations within supersymmetric gravity, a topic of ongoing research. In our work, we review minimal (N=1) off-shell two-derivative gauged supergravity in five dimensions (5D) and explore three independent four-derivative superspace invariants defined using the superspace techniques developed in arXiv:1410.8682.
These invariants give rise to various locally supersymmetric extensions of fundamental gravitational terms, such as the Einstein-Hilbert term, cosmological constants, Riemann tensor squared, Ricci tensor squared, and scalar curvature squared. By employing algorithms developed in the computer program CADABRA, we've derived for the first time the component fields' actions and primary equations of motion for these invariants, including fermions. Finally, all the covariant descendants in the multiplets of equations of motion are obtained by applying a series of Q-supersymmetry transformations.
Our recent results, detailed in our research papers (arXiv:2302.14295, arXiv:2309.07637 and arXiv:2311.00679), significantly contribute to our understanding of higher-derivative supergravity theories. These findings hold the potential for applications in the study of quantum-corrected supersymmetric black holes and next-to-leading order tests of the AdS/CFT correspondence.

Links, Jon. An unsolvable case of Yang-Baxter integrability
Speaker: Jon Links (The University of Queensland)
Time: 15:00 Fri 8 December
Place(s): 05-213
Author(s): Phillip Isaac, Jon Links, Inna Lukyanenko, Jason Werry

Formalising a verb, say "to %&∗#$", can lead to surprising ramifications for what is subsequently deemed to be un%&∗#$able. Well-known examples include those due to Cantor (uncountable), Richards (undefinable), Gödel (unprovable), and Turing (undecidable).
A vast body of work has been developed for quantum integrable models constructed from solutions of the Yang-Baxter equation. It is widely assumed that the solution of the Yang-Baxter equation implies the existence of an exact "Bethe Ansatz" solution for the model.
Using the Lie-algebraic classical Yang-Baxter equation, I will introduce an example to demonstrate that there exist integrable systems that are unsolvable. This approach formulates the problem in a manner that makes connection to classical integrability through a Lie-Poisson structure. I will also discuss the extent to which this result is independent of how "solvability" is defined.

Marquette, Ian. Polynomial algebras from Lie algebra reduction chains $\mathfrak{g} \supset \mathfrak{g}'$
Speaker: Ian Marquette (The University of Queensland)
Time: 15:00 Thu 7 December
Place(s): 05-213
Author(s): Ian Marquette

We reexamined different examples of reduction chains $\mathfrak{g} \supset \mathfrak{g}'$ of Lie algebras in order to show how the polynomials determining the commutant with respect to the subalgebra $\mathfrak{g}'$ leads to polynomial deformations of Lie algebras. These polynomial algebras have already been observed in various contexts, such as in the framework of superintegrable systems. Two relevant chains extensively studied in Nuclear Physics, namely the Elliott chain $\mathfrak{su}(3) \supset \mathfrak{so}(3)$ and the chain $\mathfrak{so}(5) \supset \mathfrak{su}(2) \times \mathfrak{u}(1)$ related to the Seniority model, are analyzed in detail from this perspective. We show that these two chains both lead to three-generator cubic polynomial algebras, a result that paves the way for a more systematic investigation of nuclear models in relation to polynomial structures arising from reduction chains. In order to show that the procedure is not restricted to semisimple algebras, we also study the chain $\hat{S}(3) \supset \mathfrak{sl}(2,\mathbb{R}) \times \mathfrak{so}(2)$ involving the centrally-extended Schrödinger algebra in $(3+1)$-dimensional space-time. This is joint work with Rutwig Campoamor-Stursberg, Danilo Latini and Yao-Zhong Zhang

Mead, William. Integrable half space exclusion process and diagonally symmetric alternating sign matrices I
Speaker: William Mead (The University of Melbourne)
Time: 16:30 Tue 5 December
Place(s): 05-213
Author(s): William Mead

We discuss a new exact expression for the transition probability of the exclusion process on the semi-infinite half-line with general open boundaries. Intermediate ghost particles imply a non-trivial

empty-to-empty transition probability for this model. We discuss an explicit Pfaffian expression for this probability that surprisingly also resolves an outstanding case related to diagonally symmetric alternating sign matrices, not dealt with by Kuperberg.

Nurcombe, Madeline. An isomorphism of diagram algebras
Speaker: Madeline Nurcombe (The University of Queensland)
Time: 14:30 Wed 6 December
Place(s): 05-213
Author(s): Madeline Nurcombe

A diagram algebra is an algebra with a basis of diagrams, and multiplication based on concatenation of diagrams. The dilute Temperley-Lieb (dTL) algebra and the Motzkin algebra are diagram algebras; the dTL algebra is used in statistical mechanics to describe loosely-packed loop models, while the Motzkin algebra was introduced as the centraliser algebra of an action of a quantum group. These algebras are defined in terms of the same basis diagrams, but different multiplication rules. We show that they are isomorphic, as long as a particular parameter of the Motzkin algebra is nonzero. Existing results for each algebra can then be applied to the other, such as their representation theory, integrable loop models and presentations.

Parr, Anthony. Super-integrability and Deformed Oscillator Realisations of Quantum TTW Hamiltonians on Constant-Curvature Manifolds and with Reflections in a Plane
Speaker: Anthony Parr (The University of Queensland)
Time: 14:30 Tue 5 December
Place(s): 05-213
Author(s): Ian Marquette, Anthony Parr

We extend the method for constructing symmetry operators of higher order for two-dimensional quantum Hamiltonians by Kalnins, Kress and Miller (2010). This expansion method expresses the integral in a finite power series in terms of lower degree integrals so as to exhibit it as a first-order differential operators. One advantage of this approach is that it does not require the a priori knowledge of the explicit eigenfunctions of the Hamiltonian nor the action of their raising and lowering operators as in their recurrence approach (2011). We obtain insight into the two-dimensional Hamiltonians of radial oscillator type with general second-order differential operators for the angular variable. We then re-examine the Hamiltonian of Tremblay, Turbiner and Winternitz (2009) as well as a deformation discovered by Post, Vinet and Zhedanov (2011) which possesses reflection operators. We will extend the analysis to spaces of constant curvature. We present explicit formulas for the integrals and the symmetry algebra, the Casimir invariant and oscillator realisations with finite-dimensional irreps which fill a gap in the literature.

Sherman, Alexander. Queer Kac-Moody algebras and an so(3) superconformal algebra
Speaker: Alexander Sherman (The University of Sydney)
Time: 14:00 Fri 8 December
Place(s): 05-213
Author(s): A. Sherman, L. Silberberg

We present the ideas behind a recent work to develop a Kac-Moody construction based on the queer Lie superalgebra $\mathfrak{q}(2)$. The finite growth queer Kac-Moody algebras are classified, and amongst them is an $\mathfrak{so}(3)$ superconformal algebra. We seek audience input for connections to known work and further directions of study.

Smith, Liam. New Deformations of Quantum Field Theories
Speaker: Liam Smith (The University of Queensland)
Time: 16:30 Wed 6 December
Place(s): 05-213
Author(s): Liam Smith

Quantum field theory (QFT) is one of the most successful frameworks to describe a wide array of physical phenomena from particle physics to condensed matter systems. It is also the core description of models of (quantum) gravity. Despite its success, the understanding of strongly coupled, interacting QFTs remains an outstanding mathematical problem. One route to make progress is to study exactly solvable models and deformations thereof, together with symmetries, to move within the set of QFTs. The TTbar deformation is an exciting tool which aids in this exploration. Defined as the determinant

of the stress-energy tensor for a two-dimensional QFT, it has proven to preserve integrability, (super-)symmetries, and it has shed new light on various areas of research including: non-local QFT, string theory, and holographic (AdS/CFT) ualities. TTbar-like deformations have been introduced also in $D > 2$ dimensions finding surprising relations with nonlocal effective actions, such as the Born-Infeld theory of non-linear Electrodynamics, that describe universal sectors of string theory at low-energy. A $\sqrt{T\bar{T}}$ type of deformation have recently also been proven to lead to the ModMAX theory of non-linear Electrodynamics that has attracted substantial attention in the last couple of years. This will summarise some of the work done in finding theories in higher dimensions which obey a $\sqrt{T\bar{T}}$ like flow equation, as well as some pioneering work on understanding the new aforementioned $\sqrt{T\bar{T}}$ deformation. Supersymmetric extensions of all results will also be presented.

van Tonder, Jaco. Integrable spin-1/2 XY central spin models
Speaker: Jaco van Tonder (The University of Queensland)
Time: 15:00 Wed 6 December
Place(s): 05-213
Author(s): Jaco van Tonder

Central spin models are closely related to Richardson-Gaudin models and have many present and potential physical applications. Recently the XX central spin model was shown to be integrable for arbitrary spin and to have a supersymmetric structure, while the eigenstates and eigenvalues were found using a Bethe-Ansatz method of solution. We have shown that integrability and supersymmetry carries over to the XY model generalisation. The conserved charges were found and a quadratic relation in these charges have been used to obtain the Bethe-Ansatz equations. A similar method was used to reproduce an alternative set of Bethe-Ansatz equations found through the much more involved modified algebraic Bethe-Ansatz (Skrypnyk 2022). These equations can be generalised to higher spin through a tensor product decomposition method developed in (Links 2017 Nucl. Phys. B). Particular limits of the charges were found to produce several other non-equivalent XY integrable models.

Vu Ho, Thao Thuan. Hamiltonian approach to 2-layer density stratified fluids.
Speaker: Thao Thuan Vu Ho (Monash University)
Time: 14:30 Thu 7 December
Place(s): 05-213
Author(s): R.Camasa, G.Falqui, G. Ortenzi, M. Pedroni, T.T Vu Ho

A Hamiltonian reduction approach is defined, studied, and finally used to derive asymptotic models of internal wave propagation in density stratified fluids in two-dimensional domains. Beginning with the general Hamiltonian formalism of Benjamin (1986 J. Fluid Mech. 165 445–74) for an ideal, stably stratified Euler fluid, the corresponding structure is systematically reduced to the setup of two homogeneous fluids under gravity, separated by an interface and confined between two infinite horizontal plates. A long-wave, small-amplitude asymptotics is then used to obtain a simplified model that encapsulates most of the known properties of the dynamics of such systems.

Zhang, Yang. Einstein metrics on homogeneous superspaces
Speaker: Yang Zhang (The University of Queensland)
Time: 14:30 Fri 8 December
Place(s): 05-213
Author(s): Mark Gould, Artem Pulemotov, Jorgen Rasmussen and Yang Zhang

In this talk, I will show you how to generalise classical geometric concepts, such as Riemannian metrics and curvatures, to supermanifolds. Specifically, we obtain explicit formulas for the Ricci curvature and scalar curvature of a homogeneous metric. Using these formulas, we solve the Einstein equation on a large class of homogeneous superspaces. This leads to examples of supermanifolds on which there are no Einstein metrics, discrete families of Einstein metrics, and continuous families of Einstein metrics. Moreover, we discover a class of Ricci-flat metrics, the existence of which indicates that the generalisation of Bochner theorem to supermanifolds does not hold.

14. Mathematics Education

Fijn, Paul. Rethinking Statistics Computer Lab Classes

Speaker: Paul Fijn (The University of Melbourne)
Time: 13:30 Thu 7 December
Place(s): 69-401
Author(s): Paul Fijn

In teaching large undergraduate statistics courses, we had previously followed a standard model of Lectures supplemented by Tutorials and Computer Lab classes. We undertook an extensive re-design of these classes to improve groupwork and collaboration, and to better utilise computing power for producing graphs and conducting analysis.
Our re-design aimed to combine the strengths of both types of classes, while removing this artificial separation between types of tasks and building a more authentic learning experience. This was achieved as part of a pilot program trialling our Next Generation tutorial rooms - small-group teaching spaces trialling new electronic whiteboard technology equipped with a fully-featured Windows PC. While this technology has its advantages, most of the benefits are possible within a standard computer lab setting.
We will discuss the materials/tasks themselves, what we learned through the process of developing them, and the evaluation of the materials for student learning.

Goberna, Miguel. Maths in Politics
Speaker: Miguel Goberna (University of Alicante)
Time: 13:30 Tue 5 December
Place(s): 69-401
Author(s): Miguel Goberna

This talk deals with the mathematical tools more often used by politicians to make decisions about health, education, culture, economy, finance, transport or national defence, that is, political decisions that directly affect citizens. Most of the selected tools have been used by three veteran politicians:

- The former Prime Minister of Israel Ehud Barak (game theory).
- The former Spanish Minister of Public Works and Transport and Minister of Foreign Affairs, and current High Representative of the European Union for Foreign Affairs and Security Policy Josep Borrell (linear and nonlinear optimization).
- The former Portuguese Minister of Education and Science Nuno Crato (statistics, multicriteria optimization and composite indices).

We also consider the mathematical tools used by politicians to plan the economy (linear inequality systems), to fight against pandemics (Voronoi diagrams, SIR epidemiological models), to capture votes (machine learning) or to optimize their effective impact through the ad hoc design of the electoral districts to increase the number of representatives (Gerrymandering).
We finally analyze the impact of significant political decisions in the development of mathematics in a selection of countries (Russia, Hungary, US, Spain, China, Turkey) and discriminated mathematical communities (Jews, African-American, women). The talk is based on the following forthcoming book, which could be used by secondary and tertiary math teachers to illustrate their courses on different branches of mathematics with motivating applications:
F.J. Aragón-Artacho and M.A. Goberna, Mathematics in Politics and Governance, Springer, to appear.

Kault, Sam. Mastery learning in first year maths
Speaker: Sam Kault (The University of Queensland)
Time: 16:30 Tue 5 December
Place(s): 69-401
Author(s): Sam Kault, Adam Piggott

We conducted a trial for competency-based assessment in a first year maths course at the University of Queensland. This course has long displayed high failure rates (typically around 30%). This is attributed to a number of factors, not least the sometimes high levels of disengagement from the large cohort of young engineering students. Students whose grades are in the bottom 20% typically enter these courses with an inadequate maths background, and often fall further behind their peers as the semester progresses.
Students sat two competency tests prior to their final exam. Each question was straightforward, and graded right or wrong, and the pass threshold was 80%. The types of questions were telegraphed in advance and multiple resits were permitted. after each failed attempt, students could review their paper, and discuss how to do better next time.

Students reported that this mode of assessment caused them to engage more with the course, and revise material earlier than they otherwise would have. The failure rate dropped markedly. Students also performed better in subsequent mathematics course.

Piggott, Adam. An assessment plan for the first year mathematics at ANU
Speaker: Adam Piggott (Australian National University)
Time: 15:00 Tue 5 December
Place(s): 69-401
Author(s): Adam Piggott

We spend a lot of mental effort in designing excellent assessments for our students. It is just as important to develop excellent ways to assess our course offerings. We describe a new plan for assessing first-year mathematics courses at ANU.

Sidhu, Leesa. Supporting Students AND Tutors in the Maths and Stats Classroom
Speaker: Leesa Sidhu (University of New South Wales Canberra)
Time: 14:00 Thu 7 December
Place(s): 69-401
Author(s): Leesa Sidhu

This presentation examines the importance of the "Care Factor" in the Maths and Stats classroom to support not only students but also the casual tutors! It shows how the evidence-based self-determination theory can be used as a framework to assist in developing and implementing simple strategies that support students' and tutors' three psychological needs – relatedness, competence and autonomy – which lead to increased success and thus wellbeing.
The talk will focus on a compulsory statistics course for Arts and Business students, which is particularly challenging to teach as many students lack confidence or interest in maths and are well outside their comfort zones. By applying wellbeing-supportive strategies, including a supportive and encouraging classroom environment, students in this course can experience success, in some cases for the first time in their maths study. The collaborative classroom environment established is also beneficial for the casual tutors who are motivated to actively engage with students and other tutors, share experiences and bounce ideas off each other.

Skerritt, Matthew Paul. Divergent Assessment in Undergraduate Mathematics
Speaker: Matthew Paul Skerritt (RMIT University)
Time: 14:30 Thu 7 December
Place(s): 69-401
Author(s): Matthew P. Skerritt

'Diverging assessments' are process-based assessments designed so that they become unique for each student while all students see a common skeleton. The term was originally coined by an inter-institutional team (who include the speaker) in the context of Cyber Security education.
In this talk, we explore the application of this assessment style to first and second year calculus classes.

Tisdell, Chris. Fostering Students to Think Like a Mathematician: Counting and Complexity in Geometry
Speaker: Chris Tisdell (University of New South Wales)
Time: 14:30 Tue 5 December
Place(s): 69-401
Author(s): Chris Tisdell

Geometry has long been a playground for students to hone their problem-solving skills through geometric constructions. These constructions involve taking a set of given data, such as a line segment or an angle, and utilizing tools like compasses, straightedges, or circle arc templates to create specific geometric entities like points or angles.
In this presentation I will illustrate how the teaching, learning and doing of geometric constructions offers opportunities for students and teachers to think like a mathematician. We explore mathematicians' core values of simplification, accuracy, and minimality by drawing on the theory of geometrography. This presentation is designed to be accessible to a wide audience. Join me!!

Tran, TriThang. What mathematical communication means to first year students
Speaker: TriThang Tran (The University of Melbourne)
Time: 14:00 Tue 5 December
Place(s): 69-401
Author(s): Alba Santin Garcia, TriThang Tran

This a joint project with Alba Santin Garcia.
This talk discusses work to understand the different ways in which first year mathematics students experience communication in mathematics. We used a qualitative research methodology – phenomenography – and interviewed a range of first year mathematics students and analysed their responses. We summarised the results in terms of different categories of experience, as typical of a phenomenographic study.
This was the authors' first foray into mathematics education research. Mathematics is often seen as a quantitative discipline. Despite this, we found that (perhaps surprisingly), the qualitative research methodology used in this study very much appealed to our mathematical sensibilities.
In addition to discussing the results of our study, I hope to convey in this talk a brief introduction to phenomenography and discuss some of its appeal to us.

Vozzo, Raymond. An assessment of active learning in large first year maths courses
Speaker: Raymond Vozzo (The University of Adelaide)
Time: 16:00 Tue 5 December
Place(s): 69-401
Author(s): Stuart Johnson, Jonathan Tuke and Raymond F. Vozzo

Many recent studies have expounded the benefits of active learning in tertiary education. There are many challenges to implementing these techniques at large scale (for example of the type seen in first year maths courses) and among the many solutions to this problem one of the more well known is peer instruction.
In this talk, I will describe recent work in which we have implemented various versions of this in level I courses at the University of Adelaide and assessed the efficacy of these.
This is joint work with Stuart Johnson and Jonathan Tuke.

15. Number Theory

Afifurrahman, Muhammad. Arithmetic statistics of rational matrices of bounded height
Speaker: Muhammad Afifurrahman (UNSW Sydney)
Time: 15:00 Tue 5 December
Place(s): 01-E212
Author(s): Muhammad Afifurrahman

Consider the set of matrices whose entries are rational numbers of height at most H. In this talk, we present several bounds related to the arithmetic statistics of this set, e.g., on the number of matrices with a fixed rank or determinant or characteristic polynomial. These results can be seen as analogues to several known results on statistics of integer matrices of bounded height.
Joint work with Alina Ostafe and Igor E. Shparlinski.

Bagshaw, Christian. Sequences of Irreducible Polynomials
Speaker: Christian Bagshaw (University of New South Wales)
Time: 16:00 Tue 5 December
Place(s): 01-E212
Author(s): Christian Bagshaw

Euclid's proof of the infinitude of the primes naturally gives rise to a procedure for producing an infinite sequence of primes: multiply the primes currently in your sequence, and take as the next term the smallest prime factor of this product plus 1. Little is known about these sequences and the primes contained within them, but a number of relaxations and variations have been investigated. Naturally, questions arise about the distribution of square-free integers in arithmetic progressions. In this talk, we will discuss some recent results regarding similar questions in the setting of polynomials over finite fields.

Bellotti, Chiara. Explicit zero density estimate near unity
Speaker: Chiara Bellotti (UNSW Canberra)
Time: 14:30 Tue 5 December
Place(s): 01-E212
Author(s): Chiara Bellotti

In this talk we will present the first explicit zero-density estimate for ζ of the form $N(\sigma,T) \leq AT^{B(1-\sigma)^{3/2}}(\log T)^C$, with an improved log-power.

Dudek, Adrian. Prime Numbers in Short Intervals on RH
Speaker: Adrian Dudek (The University of Queensland)
Time: 13:30 Thu 7 December
Place(s): 01-E212
Author(s): Adrian Dudek

The connection between the zeroes of the Riemann zeta-function and the distribution of prime numbers is well known.
In this talk I will discuss some recent joint work with Michaela Cully-Hugill on explicit results for primes in short intervals on the assumption of the Riemann hypothesis. I will also point out what the limitations of the method are and how others can improve on our results.

Fergusson, Kevin. Differential Equations Satisfied by Modular Forms
Speaker: Kevin Fergusson (Bond University)
Time: 15:00 Wed 6 December
Place(s): 01-E212
Author(s): Kevin Fergusson

An important source of applications of modular forms in many branches of mathematics is the fact that if we express a modular form $f(z)$ of weight $k \geq 0$ as a function of a modular function $t(z)$, i.e., as $f(z) = \Phi(t(z))$, then Φ satisfies a $(k+1)$-st order linear differential equation with algebraic coefficients. In this talk, we investigate what Φ is explicitly and what the differential Galois group of the linear differential equation can tell us about the nature of its solutions.

Hussain, Mumtaz. Continued fractions and Diophantine approximation
Speaker: Mumtaz Hussain (La Trobe University)
Time: 16:30 Wed 6 December
Place(s): 01-E212
Author(s): Mumtaz Hussain

In this talk, I will describe the metrical theory of various limsup sets of real numbers that exhibit growth of partial quotients in their continued fractions. Furthermore, I will demonstrate how these sets provide valuable insights into various Diophantine sets of interest.

Kerr, Bryce. Coppersmith's method in many variables
Speaker: Bryce Kerr (UNSW Canberra)
Time: 14:30 Thu 7 December
Place(s): 01-E212
Author(s): Bryce Kerr

Coppersmith's method is a fundamental method in cryptography which allows one to efficiently computer small solutions to polynomial congruences. In more than one variable, the success of Coppersmith's method is based on a heuristic assumption that certain polynomials which occur as the output of a lattice basis reduction algorithm are algebraically independent. In this talk I'll discuss some applications of Coppersmith's method and describe joint work with Riley Baird and Igor Shparlinski which shows that with a high probability one may remove the heuristic assumption mentioned above.

Leong, Nicol. Lower bounds on the zeta function
Speaker: Nicol Leong (UNSW Canberra)
Time: 13:30 Tue 5 December
Place(s): 01-E212
Author(s): Nicol Leong

It is known that the zeta function can be bounded from below by O(log t). However, obtaining a reasonable explicit constant is a challenge, as the function increases rapidly in size the closer it gets to a zero. In this talk we will discuss some complex analytic methods used in tackling this problem.

Nikolic, Dion. Counting the Number and Dimension of Classes of Matrix Solutions for a Given Polynomial
Speaker: Dion Nikolic (UNSW Canberra)
Time: 16:30 Tue 5 December
Place(s): 01-E212
Author(s): Dion Nikolic

In this talk we extend the Fundamental Theorem of Algebra to matrix polynomials by finding a formula and the asymptotic behaviour for the number of equivalence classes of matrix solutions for any given polynomial. We also study these equivalence classes as Lie groups and find a formula and the asymptotic behaviour for the average dimension amongst equivalence classes solving a polynomial.

Shulga, Nikita. Racidal bound for Zaremba's conjecture
Speaker: Nikita Shulga (La Trobe University)
Time: 16:00 Wed 6 December
Place(s): 01-E212
Author(s): Nikita Shulga

Famous Zaremba's conjecture (1971) states that for each positive integer $q \geq 2$, there exists positive integer $1 \leq a < q$, coprime to q, such that if you expand a fraction a/q into a continued fraction $a/q = [a_1, \ldots, a_n]$, all of the coefficients a_i's are bounded by some absolute constant $\mathfrak{k}$, independent of q. Zaremba conjectured that this should hold for $\mathfrak{k} = 5$. In 1986, Niederreiter proved Zaremba's conjecture for numbers of the form $q = 2^n, 3^n$ with $\mathfrak{k} = 3$ and for $q = 5^n$ with $\mathfrak{k} = 4$. In this talk we prove that for each number $q \neq 2^n, 3^n$, there exists a, coprime to q, such that all of the partial quotients in the continued fraction of a/q are bounded by $\mathrm{rad}(q) - 1$, where $\mathrm{rad}(q)$ is the radical of an integer number, i.e. the product of all distinct prime numbers dividing q.
In particular, this means that Zaremba's conjecture holds for numbers q of the form $q = 2^n 3^m, n, m \in \mathbb{N} \cup \{0\}$ with $\mathfrak{k} = 5$, generalizing Neiderreiter's result.

Simonic, Aleksander. Some conditional estimates for functions in the Selberg class
Speaker: Aleksander Simonic (University of New South Wales Canberra)
Time: 17:00 Wed 6 December
Place(s): 01-E212
Author(s): Aleksander Simonič

In this talk I will present recent progress in obtaining conditional (GRH) estimates for $(\mathcal{L}'/\mathcal{L})(s)$ and $\log \mathcal{L}(s)$, when $\mathcal{L}$ is an element in the Selberg class of functions. The results are divided into two groups, according to whether s is close to the critical line or not. We are able to obtain effective results while assuming the strong λ-conjecture and a polynomial Euler product representation for $\mathcal{L}$. This is a joint work with N. Palojärvi (The University of Helsinki).

Trudgian, Timothy. Defrosting Ingham's frozen theorem for zeta
Speaker: Timothy Trudgian (UNSW Canberra)
Time: 14:00 Thu 7 December
Place(s): 01-E212
Author(s): Timothy Trudgian

An early result by Ingham in 1937 gives a crispy and delicious connection between the growth of the zeta-function and the distribution of primes, which is always good. This has fallen down the pecking order due to the superiority of Ingham's 1940 work. Rather than merely roasting the earlier result, I shall outline an idea of slowly, carefully, bringing it back to the table using ideas and projects from the UNSW number theory group.

Yang, Andrew. On optimal exponent pairs
Speaker: Andrew Yang (UNSW Canberra)
Time: 14:00 Tue 5 December
Place(s): 01-E212
Author(s): Andrew Yang

In this talk we quantify the set of known exponent pairs (k, ℓ) and develop a framework to compute the optimal exponent pair for an arbitrary objective function. Applying this methodology, we make progress on several open problems, including bounds of the Riemann zeta-function $\zeta(s)$ in the critical strip, estimates of the moments of $\zeta(1/2 + it)$, zero-density estimates of $\zeta(s)$ and the generalised Dirichlet divisor problem.

This is joint work with Tim Trudgian

16. Optimisation

Abolghasemi, Mahdi. Approximating Solutions to the Knapsack Problem using the Lagrangian Dual Framework
Speaker: Mahdi Abolghasemi (The University of Queensland)
Time: 16:30 Tue 5 December
Place(s): 14-116
Author(s): Mahdi Abolghasemi, Mitchel Keegan

The Knapsack Problem is a classic problem in combinatorial optimisation. Solving these problems may be computationally expensive. Recent years have seen a growing interest in the use of deep learning methods to approximate the solutions to such problems. A core problem is how to enforce or encourage constraint satisfaction in predicted solutions. A promising approach for predicting solutions to constrained optimisation problems is the Lagrangian Dual Framework which builds on the method of Lagrangian Relaxation. In this paper we develop neural network models to approximate Knapsack Problem solutions using the Lagrangian Dual Framework while improving constraint satisfaction. We explore the problems of output interpretation and model selection within this context. Experimental results show strong constraint satisfaction with a minor reduction of optimality as compared to a baseline neural network which does not explicitly model the constraints.

Adly, Samir. Enhancing Sensitivity Analysis for Monotone Inclusions Through Proto-Differentiability of the Resolvent Operator.
Speaker: Samir Adly (University of Limoges)
Time: 13:30 Tue 5 December
Place(s): 14-116
Author(s): S.Adly and R. T. Rockafellar

This presentation focuses on examining the sensitivity to perturbation of parametrized variational inclusions that involve maximal monotone operators within a Hilbert space. We consider the perturbation of all data relevant to the problem. By incorporating the concept of proto-differentiability for a multifunction and introducing the notion of semi-differentiability for a single-valued map, we establish the differentiability of the solution to a parametrized monotone inclusion. Additionally, we provide an exact formula for the proto-derivative of the resolvent operator associated with the maximal monotone parameterized variational inclusion. This demonstrates that the derivative of the solution to the parametrized variational inclusion follows a consistent pattern, as it, in turn, becomes a solution to a variational inclusion that involves the semi-derivative and the proto-derivative of the associated maps. We also offer an application demonstrating the sensitivity analysis of a parametrized primal-dual composite monotone inclusion. We establish that, under certain sufficient conditions on the data, both the primal and dual solutions are differentiable, and their derivatives belongs to the derivative of the associated Kuhn-Tucker set.

Bui, Thi Hoa. Cutting Plane Algorithms are Exact for Euclidean Max-Sum Problems
Speaker: Thi Hoa Bui (Curtin University)
Time: 14:30 Fri 8 December
Place(s): 14-116
Author(s): Thi Hoa Bui

We discuss the binary quadratic programs in which the objective is defined by a Euclidean distance matrix, subject to a general polyhedral constraint set. This class of nonconcave maximisation problems includes the capacitated, generalised and bi-level diversity problems as special cases. We introduce two exact cutting plane algorithms to solve this class of optimisation problems. The new algorithms remove the need for a concave reformulation, which is known to significantly slow down convergence. We establish exactness of the new algorithms by examining the concavity of the quadratic objective in a given direction, a concept we refer to as directional concavity. Numerical results show that the algorithms outperform other exact methods for benchmark diversity problems (capacitated, generalised and bi-level), and can easily solve problems of up to three thousand variables.

Burachik, Regina S.. Optimal Control Duality and the Douglas–Rachford Algorithm
Speaker: Regina S. Burachik (University of South Australia)
Time: 16:00 Tue 5 December
Place(s): 14-116
Author(s): RS Burachik, BI Caldwell, CY Kaya, WM Moursi

We explore the relationship between the dual of a weighted minimum-energy control problem, a special case of linear-quadratic optimal control problems, and the Douglas–Rachford (DR) algorithm. We obtain an expression for the fixed point of the DR operator as applied to solving the optimal control problem, which in turn devises a certificate of optimality that can be employed for numerical verification. The fixed point and the optimality check are illustrated in two example optimal control problems

Diaz Millan, Reinier. Extragradient method with feasible inexact projection to variational inequality problem
Speaker: Reinier Diaz Millan (Deakin University)
Time: 15:00 Fri 8 December
Place(s): 14-116
Author(s): R. Diaz Millan; O. Pereira Ferreira; J. Ugon

The variational inequality problem in finite-dimensional Euclidean space is addressed in this paper, and two inexact variants of the extragradient method are proposed to solve it. Instead of computing exact projections on the constraint set, as in previous versions extragradient method, the proposed methods compute feasible inexact projections on the constraint set using a relative error criterion. The first version of the proposed method provided is a counterpart to the classic form of the extragradient method with constant steps. In order to establish its convergence we need to assume that the operator is pseudo-monotone and Lipschitz continuous, as in the standard approach. For the second version, instead of a fixed step size, the method presented finds a suitable step size in each iteration by performing a line search. Like the classical extragradient method, the proposed method does just two projections into the feasible set in each iteration. A full convergence analysis is provided, with no Lipschitz continuity assumption of the operator defining the variational inequality problem.

Duong, Huyen. Robust Solutions of Single-Leader-Multi-Follower Games
Speaker: Huyen Duong (University of New South Wales)
Time: 14:30 Wed 6 December
Place(s): 14-116
Author(s): D. T. K. Huyen and V. Jeyakumar

This paper establishes a hierarchy of semidefinite relaxations, whose associated sequence of optimal values converges to the optimal value of a robust polynomial single-leader-multi-follower game. In this game, the data are perturbed within a polytope set, and the followers' problems are linear. Illustrative examples have also been provided and analyzed.

Goberna, Miguel. Duality and limiting formulas for convex infinite optimization problems
Speaker: Miguel Goberna (University of Alicante)
Time: 13:30 Wed 6 December
Place(s): 14-116
Author(s): Miguel Goberna

This talk presents new duality theorems for a convex optimization problem P with an arbitrary number of constraints posed on real linear spaces (usually locally convex ones). In the first part of the talk we consider the ordinary Lagrange-Haar dual problem, the conic Lagrangian dual problem, and the sup-dual problem in the framework of limiting formulas for P. In particular, we correct a classical limiting formula of Karney (1983) for convex semi-infinite programs (where the decision space is finite-dimensional). In the second part, we associate with P and a given non-empty family $\mathcal{H}$ of finite subsets of its index set, a suitable Lagrangian-Haar dual problem called relaxed Lagrangian dual of P. We present results on the equivalence of P to some subproblem obtained by replacing its whole index set by some element of $\mathcal{H}$, zero duality theorems, strong and reverse strong theorems, and optimality conditions for this new type of duality. The talk is based on Goberna and M. Volle (2022)
References:
D.F. Karney, A duality theorem for semi-infinite convex programs and their finite subprograms. Math. Programming 27, 75-82 (1983).

M.A. Goberna and M. Volle, Duality for convex infinite optimization on linear spaces, Optimization Letters 16, 2501-2510 (2022)
Keywords: Convex infinite programming, Lagrangian duality, Haar duality, Limiting formulas.

He, Kerry. Convex Optimization Methods in Quantum Information Theory
Speaker: Kerry He (Monash University)
Time: 15:00 Tue 5 December
Place(s): 14-116
Author(s): Kerry He

Many important systems in quantum information theory are quantified using convex optimization problems. These problems typically involve minimizing or maximizing functions composed of quantum entropies, which are complex nonlinear functions of matrices. Therefore, it is not straightforward how standard methods can be applied to solve these types of problems. In this work, we aim to devise generalized, efficient algorithms for problems in quantum information theory with provable convergence guarantees, by exploring both first-order and second-order methods.

Huang, Yingkun (Queenie). Second-Order Cone Programs for Distributionally Robust Optimisation, with Applications to Revenue Maximisation and Insurance Claims Management
Speaker: Yingkun (Queenie) Huang (University of New South Wales)
Time: 14:00 Wed 6 December
Place(s): 14-116
Author(s): Queenie Huang

The tasks of revenue maximisation under stochastic supplies and insurance claims management with uncertain claim sizes can be formulated as Distributionally Robust Optimisation (DRO) problems. Unfortunately, solving DRO problems are generally computationally intractable because evaluating a multi-dimensional integral for the expectations and searching through the infinite-dimensional space of probability distributions is numerically hard. In this talk, we present an approach for transforming DRO problems with quadratic functions into Second-Order Cone Programs (SOCPs). This is done by deriving, for the first time, a new extension of the celebrated S-Lemma to minimax quadratic systems, and employing conic linear programming duality. The resulting SOCPs can be solved efficiently using commonly available software. We illustrate our approach by giving numerical results for the revenue maximisation and insurance claims management problems.

Kaya, Yalcin. Infeasible Optimal Control Problems
Speaker: Yalcin Kaya (University of South Australia)
Time: 16:00 Wed 6 December
Place(s): 14-116
Author(s): RS Burachik, CY Kaya, WM Moursi

We consider infeasible and critically feasible optimal control problems, where the dynamics is governed by linear differential (state) equations with end states specified and the control variables constrained by simple bounds. First, two constraint sets are defined: one involving the ODE with specified end states and the other involving the box constraints on the control. The problem is said to be infeasible when the intersection of these two sets is empty. The problem of finding an approximate solution to the infeasible problem is posed as one of minimizing the distance (or the "gap") between the two constraint sets. It is proved that, under a controllability assumption, the control belonging to the box constraint set and solving this problem is of bang–bang type, i.e., the value of the control variable switches between its lower and upper bounds. The problem of finding a critical feasible solution, i.e., a solution for the least bound on the control resulting in a nonempty intersection of the two constraint sets, is also formulated, and it is proved that the critically feasible optimal control is also of bang–bang type. An analytical critically feasible solution is presented for the control problem involving the double integrator with arbitrary end states. Further illustrations of the results are given on various more challenging example applications.

Peiris, Vinesha. A comparison of rational and neural network based approximations
Speaker: Vinesha Peiris (Curtin University)
Time: 15:00 Thu 7 December
Place(s): 14-116
Author(s): Nadia Sukhorukova, Julien Ugon, Reinier Diaz Millan

Rational functions and rational approximation techniques are very efficient and powerful tools that have been widely used for function approximation. Lately, deep learning has gained attention due to its recent success in many different sectors. Deep learning techniques are based on neural networks, which contain a certain number of layers to perform several mathematical transformations on the input. In this talk, we discuss 6 distinct approaches (4 different neural networks, Differential Correction method and AAA algorithm) that one can use to approximate a given function. In order to determine which technique works best for function approximation, we compare the computational time and the objective function value for each method.

Pham, Tan. Minimizing a separable sum coupled by a difference of functions and linear constraints
Speaker: Tan Pham (Federation University Australia)
Time: 15:00 Wed 6 December
Place(s): 14-116
Author(s): Tan Pham, Minh N. Dao, Nargiz Sultanova, Rakibuzzaman Shah, Syed Islam

In this paper, we develop a splitting algorithm for solving a broad class of linearly constrained composite optimization problems, whose objective function is the separable sum of possibly nonconvex nonsmooth functions and a smooth function, coupled by a difference of functions. This structure encapsulates numerous significant nonconvex and nonsmooth optimization problems in the current literature including the linearly constrained difference-of-convex problems. Relying on the successive linearization and alternating direction method of multipliers, the proposed algorithm exhibits the global subsequential convergence to a stationary point of the underlying problem. We also establish the convergence of the full sequence generated by our algorithm under the Kurdyka–Łojasiewicz property and some mild assumptions. The efficiency of the proposed algorithm is tested on a robust principal component analysis problem and a nonconvex optimal power flow problem.

Rajapaksha, Thakshila. Linear convergence of tilt-correct DFO proximal bundle method
Speaker: Thakshila Rajapaksha (University of Wollongong)
Time: 17:00 Wed 6 December
Place(s): 14-116
Author(s): Thakshila Rajapaksha

In this presentation, we will showcase the linear convergence of a derivative-free proximal bundle method known as the tilt-correct DFO proximal bundle method. This method is specifically designed to find an approximate proximal point for a nonsmooth convex objective function. Although we have exact function values at hand, our subgradients are inexact. This means that the value of the model function at the prox-center may be higher than the original function value due to the use of an approximate subgradient. As a result, we cannot always expect a lower linearization, which is crucial for ensuring convergence. To address this issue, a correction is applied to the approximated subgradient. However, since the model function is not always an underestimator of the objective function, we lose the benefit of convexity. To achieve the convergence rate of the algorithm, we establish a suitable framework and use the subdifferential-based error bound on the distance to critical points. The subgradient of the model produced through this process may not be an accurate subgradient of the actual function at any point along iterations. Therefore, we transport model subgradients to a nearby point where they are subgradients of the objective function.

Rieger, Janosch. Generalised Gearhart-Koshy acceleration is a Krylov space method
Speaker: Janosch Rieger (Monash University)
Time: 14:00 Tue 5 December
Place(s): 14-116
Author(s): Markus Hegland (co-author) and Janosch Rieger (presenter)

The Gearhart-Koshy acceleration for the Kaczmarz method for linear systems is a line-search with the unusual property that it does not minimise the residual, but the error. Recently, we generalized this acceleration from a line-search to a search in affine subspaces. In this talk, we demonstrate that this affine search is a Krylov space method that is neither a CG-type nor a MINRES-type method, and that it is mathematically equivalent with a more canonical Gram-Schmidt-based method.

Roosta, Fred. A Newton-MR Algorithm With Complexity Guarantees for Nonconvex Optimization
Speaker: Fred Roosta (The University of Queensland)
Time: 14:30 Thu 7 December
Place(s): 14-116
Author(s): Fred Roosta

We consider variants of Newton-MR algorithm for solving unconstrained, smooth, but non-convex optimization problems. Unlike the overwhelming majority of Newton-type methods, which rely on conjugate gradient algorithm as the primary workhorse for their respective sub-problems, Newton-MR employs minimum residual (MINRES) method. Recently, it has been established that MINRES has inherent ability to detect non-positive curvature directions as soon as they arise and certain useful monotonicity properties will be satisfied before such detection. We leverage these recent results and show that our algorithms come with desirable properties including competitive first and second-order worst-case complexities. Numerical examples demonstrate the performance of our proposed algorithms.

Smee, Oscar. Inexact Newton's method for non-convex constrained optimization
Speaker: Oscar Smee (The University of Queensland)
Time: 14:30 Tue 5 December
Place(s): 14-116
Author(s): Oscar Smee

We seek to develop second order algorithms for solving large scale, nonconvex problems with non-negativity constraints. Non-negativity constraints are employed by a variety of machine learning techniques, such as non-negative least squares, non-negative matrix factorisation and the training of certain kinds of neural networks (e.g., input convex neural networks). First order methods, like projected gradient descent, can exhibit slow convergence when dealing with ill-conditioned objectives. On the other hand, popular second order methods like projected Newton method or interior point methods can suffer from difficult sub-problems and significant ill-conditioning. In the case of convex problems, a version of Bertsekas' two metric projection method alleviates these issues by combining projected gradient steps at the boundary of the feasible set with Newton steps on the interior. We adapt this method to the large scale, nonconvex setting by using Newton-MR, a recently developed inexact Newton method, instead of the full Newton step. Newton-MR is based on the MINRES inner problem solver and addresses nonconvexity by identifying and utilising negative curvature as it arises in the MINRES iterations.

Sukhorukova, Nadia. Deep learning and its mathematical nature
Speaker: Nadia Sukhorukova (Swinburne University of Technology)
Time: 13:30 Thu 7 December
Place(s): 14-116
Author(s): Nadezda Sukhorukova

Deep learning is one of the key tools in the modern area of Artificial Intelligence. This recognition is well-deserved due to many practical applications, where deep learning demonstrated its efficiency, including data analysis and signal and image processing and many others.
The origin of deep learning is mathematical in its nature. Essentially, the objective of deep learning is to solve an approximation problem: optimise the weights (parameters) of the network. These weights can be considered as decision variables of certain optimisation problems, whose objective functions represent inaccuracy. Therefore, it is natural to approach this problem can be treated using modern optimisation tools. Solid mathematical background of deep learning was established, but there are still many open mathematical problems. These works rely on the results of the celebrated Kolmogorov-Arnold Theorem and the Thirteenth Hilbert's problem.

Uteda, Daniel. Active Support Identification for Finite Max Functions
Speaker: Daniel Uteda (The University of Melbourne)
Time: 16:30 Wed 6 December
Place(s): 14-116
Author(s): Daniel Uteda

Minimisation of finite max functions is prevalent throughout nonsmooth optimisation. However, the set of functions equal to the maximum, called the support, at the minimiser can be significantly smaller than the original index set. After measuring this desired support, we can thus create a simpler but equivalent problem by discarding a potentially large proportion of functions. This in turn leads to

improved convergence rates at the least, and for some problems the information obtained can give rise to an analytic solution. In this talk based on recent work, we begin by describing a simple model to solve the original minimisation problem, which can exploit the first-order information of the functions inside the maximum. We then describe how the support can be measured, without any knowledge of the solution, using several approaches, some of these new and some existing. Time permitting, we will then present some numerical results on the accuracy of these approaches, and how they can be used in a numerical setting to achieve faster convergence rates

Xu, Hong-Kun. Extra-anchored Halpern Iteration and Applications in Variational Inequalities
Speaker: Hong-Kun Xu (Hangzhou Dianzi University)
Time: 13:30 Fri 8 December
Place(s): 14-116
Author(s): Hong-Kun Xu

Halpern iteration method was introduced by Halpern in 1967 to find a fixed point of a nonexpansive mapping in a Hilbert space. It has recently been paid much attention due primarily to its applications in machine learning such as generative adversarial nets (GANs).
In this talk we will report some convergence results on the extra-anchored Halpern iteration method and its applications in variational inequalities.

Yuan, Yongjia. Clustering data streams using an adaptive cluster-preserving approach
Speaker: Yongjia Yuan (Federation University Australia)
Time: 17:00 Tue 5 December
Place(s): 14-116
Author(s): Yongjia Yuan

Clustering data streams is a challenging problem, and the following conditions should be considered: (i)data points may arrive continuously; (ii) there is no control over the order in which the data points should be processed; and (iii) the size of a stream is (potentially) unbounded. We introduced a new algorithm for clustering data streams. The proposed algorithm, called IncStream, involves an incremental clustering approach and a procedure for finding a set of cluster determining points. A data set is represented as a sequence of blocks so that each block can be stored in the computer's random access memory. Compared to traditional global optimization solvers, the algorithm for incremental construction of clusters can quickly find k global or near-global solutions to clustering problems. The incremental clustering approach is applied at each iteration of the IncStream algorithm to each block to find a collection of cluster distributions. Then, the special procedure is utilized to find a set of cluster determining points for each distribution and weights of these points. This set consists of centers, points from dense areas, contour points, and core points of clusters. In the next iteration of the IncStream algorithm, these points with their weights are added to the new block. The IncStream algorithm continues until all blocks of the data set are clustered. The performance of the new algorithm is demonstrated using synthetic and large real-world data sets and compared with that of five other algorithms for clustering data streams.

17. Partial Differential Equations

Cirstea, Florica Corina. Boundedness of solutions to singular anisotropic elliptic equations
Speaker: Florica Corina Cirstea (The University of Sydney)
Time: 13:30 Tue 5 December
Place(s): 08-257
Author(s): Barbara Brandolini and Florica Cirstea

In this talk, we present new results on the uniform boundedness of solutions for a general class of Dirichlet anisotropic elliptic problems of the form

$$-\Delta_{\overrightarrow{p}} u + \Phi_0(u, \nabla u) = \Psi(u, \nabla u) + f \quad \text{in } \Omega, \qquad u = 0 \quad \text{on } \partial\Omega,$$

where Ω is a bounded domain in $\mathbb{R}^N$ $(N \geq 2)$, $\Delta_{\overrightarrow{p}} u = \sum_{j=1}^N \partial_j(|\partial_j u|^{p_j-2}\partial_j u)$ and $\Phi_0(u, \nabla u) = \left(\mathfrak{a}_0 + \sum_{j=1}^N \mathfrak{a}_j |\partial_j u|^{p_j}\right) |u|^{m-2}u$, with $\mathfrak{a}_0 > 0$, $m, p_j > 1$, $\mathfrak{a}_j \geq 0$ for $1 \leq j \leq N$ and $N/p = \sum_{k=1}^N (1/p_k) > 1$. We assume that $f \in L^r(\Omega)$ with $r > N/p$. The feature of this study is the inclusion of a possibly singular gradient-dependent term $\Psi(u, \nabla u) = \sum_{j=1}^N |u|^{\theta_j-2}u\,|\partial_j u|^{q_j}$, where

$\theta_j > 0$ and $0 \leq q_j < p_j$ for $1 \leq j \leq N$. The existence of weak solutions is contained in a recent paper by the authors.
This is joint work with Barbara Brandolini (Università degli Studi di Palermo).

Du, Yihong. Rate of acceleration in propagation of the KPP equation with nonlocal diffusion and free boundaries
Speaker: Yihong Du (University of New England)
Time: 16:30 Fri 8 December
Place(s): 08-257
Author(s): Yihong Du and Wenjie Ni

Accelerated propagation is a new phenomenon for nonlocal diffusion equations. In this talk I will discuss how the exact rate of acceleration can be determined for the KPP equation with nonlocal diffusion and free boundaries, which can used to describe the invasion of a new species into new territories.

Gell-Redman, Jesse. New perspectives in scattering for nonlinear evolution equations
Speaker: Jesse Gell-Redman (None)
Time: 14:30 Thu 7 December
Place(s): 08-257
Author(s): Jesse Gell-Redman

I will discuss a new methodology for proving small data scattering for the nonlinear Schrödinger equation, which avoids the use of Strichartz estimates, and uses instead methods from microlocal analysis. This methodology is flexible and can in principle be applied to massive wave propagation as in the Klein-Gordon or massive Dirac equations. This is joint work with Andrew Hassell and Sean Gomes and with Dean Baskin and Moritz Doll

Hauer, Daniel. An extension problem for the logarithmic Laplacian
Speaker: Daniel Hauer (The University of Sydney)
Time: 13:30 Thu 7 December
Place(s): 08-257
Author(s): Huyuan Chen (Jiangxi Normal University, China), Daniel Hauer (Univeristy of Sydney) and Tobias Weth (Goethe-Universität Frankfurt, Germany)

Motivated by the fact that for positive s tending to zero the fractional Laplacian converges to the identity and for s tending to 1 to the local Laplacian, Chen and Weth [Comm. PDE 44 (11), 2019] introduced the logarithmic Laplacian as the first variation of the fractional Laplacian at $s = 0$. In particular, they showed that the logarithmic Laplacian admits an integral representation and can, alternatively, be defined via the Fourier-transform with a logarithmic symbol. The logarithmic Laplacian turned out to be an important tool in various mathematical problems; for instance, to determine the asymptotic behavior as the order s tends to zero of the eigenvalues of the fractional Laplacian equipped with Dirichlet boundary conditions (see, e.g., [Feulefack, Jarohs, Weth, J. Fourier Anal. Appl. 28(2), no. 18, 2022]), in the study of the logarithmic Sobolev inequality on the unit sphere [Frank, König, Tang, Adv. Math. 375, 2020], or in the geometric context of the 0-fractional perimeter, see [De Luca, Novaga, Ponsiglione, ANN SCUOLA NORM-SCI 22(4), 2021]. Caffarelli and Silvestre [Comm. Part. Diff. Eq. 32(7-9), (2007)] showed that for every sufficiently regular u, the values of the fractional Laplacian at u can be obtained by the co-normal derivative of an s-harmonic function w_u on the half-space (by adding one more space dimension) with Dirichlet boundary data u. This extension problem represents the important link between an integro-differential operator (the nonlocal fractional Laplacian) and a local 2nd-order differential operator. This property has been used frequently in the past in many problems governed by the fractional Laplacian.

In this talk, I will present an extension problem for the logarithmic Laplacian, which shows that this nonlocal integro-differential operator can be linked with a local Poisson problem on the (upper) half-space, or alternatively (after reflection) in a space of one more dimension. As an application of this extension property, I show that the logarithmic Laplacian admits a unique continuous property.

The results presented here were obtained in joint work with Huyuan Chen (Jiangxi Normal University, China) and Tobias Weth (Goethe-Universität Frankfurt, Germany)

Krummel, Brian. A planar frequency function for area minimizing currents
Speaker: Brian Krummel (The University of Melbourne)
Time: 14:30 Tue 5 December
Place(s): 08-257
Author(s): Brian Krummel and Neshan Wickramasekera

In his monumental work in the early 1980s, Almgren showed that the singular set of an n-dimensional locally area minimizing submanifold T has Hausdorff dimension at most $n-2$. The main difficulty is that higher codimension area minimizers can admit branch point singularities, i.e. singular points at which one tangent cone is a plane of multiplicity two or greater. Almgren's lengthy proof showed first that the set of non-branch-point singularities has Hausdorff dimension at most $n-2$ using an elementary argument based on tangent cone type, and developed a powerful array of ideas to obtain the same dimension bound for the branch separately. In this strategy, the exceeding complexity of the argument stems largely from the lack of an estimate giving decay of T towards a unique tangent plane at a branch point.

We discuss a new intrinsic frequency function for a locally area minimizing submanifold T relative to a plane, called the planar frequency function. The planar frequency function satisfies an approximate monotonicity property, and takes correct values (i.e. ≤ 1) whenever T is a cone (for which planar frequency is defined) and the base point is the vertex of the cone. Let $\mathcal{B}$ be the set of branch points at which T decays towards a (unique) plane faster than a fixed positive power of the scale, and $\mathcal{S}$ be the set of all other singular points of T. Using the properties of the planar frequency function, we establish a key approximation property along $\mathcal{S}$: near each point of $\mathcal{S}$ and at each sufficiently small scale, T is significantly closer to some non-planar cone than to any plane. We also use the approximate monotonicity of the planar frequency function to study the dimension and structure of $\mathcal{B}$, and in particular to prove that $\mathcal{B}$ is countably $(n-2)$-rectifiable.

Kwong, Kwok-Kun. Inverse curvature flow and two families of weighted geometric inequalities involving three quantities
Speaker: Kwok-Kun Kwong (University of Wollongong)
Time: 14:00 Thu 7 December
Place(s): 08-257
Author(s): Kwok-Kun Kwong, Wei Yong

Inverse curvature type flows have long been recognized for their use in deriving various geometric inequalities, such as the Riemannian Penrose inequality, isoperimetric-type inequalities, and Alexandrov-Fenchel inequalities. Most of these results are comparison theorems of two geometric quantities, though there are a few exceptions. In this talk, I will present two families of weighted geometric inequalities that involve three geometric quantities for hypersurfaces in some warped product manifolds. A main ingredient is identifying monotone quantities involving two quantities along the flow. This is joint work with Yong Wei.

Larsen-Scott, James. Spectral Optimisation of the Robin Laplacian on Quadrilaterals
Speaker: James Larsen-Scott (Monash University)
Time: 15:00 Tue 5 December
Place(s): 08-257
Author(s): Julie Clutterbuck and James Larsen-Scott

Given a collection of domains of fixed volume, which domain maximises or minimises the first eigenvalue of the Laplacian? A famous question of this type is Lord Rayleigh's conjecture that the drum shape that minimises the lowest frequency of vibration of the drum is the disk. This conjecture would later be resolved by the proof of the Faber-Krahn inequality, the now well-known result that for Dirichlet boundary conditions the ball is the minimising domain. Similarly, when one is restricted to triangular or quadrilateral domains, the equilateral triangle and the square are the minimisers, respectively. We discuss the current state of knowledge with regards to these shape optimisation problems when one considers Robin boundary conditions instead. Furthermore, we provide a new result that for quadrilateral domains, the square is a local minimiser when the Robin boundary parameter is negative, alongside some asymptotic results.

Liu, Jiakun. How does the free boundary touch the fixed boundary
Speaker: Jiakun Liu (University of Wollongong)
Time: 14:00 Tue 5 December
Place(s): 08-257
Author(s): Jiakun Liu
TBA

Pulemotov, Artem. Hermitian metrics with vanishing second Chern Ricci curvature
Speaker: Artem Pulemotov (The University of Queensland)
Time: 15:00 Fri 8 December
Place(s): 08-257
Author(s): Kyle Broder and Artem Pulemotov
We describe a rigidity phenomenon exhibited by the second Chern Ricci curvature of a Hermitian metric on a compact complex manifold. This yields a characterisation of second Chern Ricci-flat Hermitian metrics on several types of manifolds as well as a range of non-existence results for such metrics.

Thompson, Jack. Some nonlocal geometric identities with applications to classical formulas in Riemannian geometry
Speaker: Jack Thompson (The University of Western Australia)
Time: 16:00 Wed 6 December
Place(s): 08-257
Author(s): Jack Thompson
It is a classical result in the theory of nonlocal equations that the fractional Laplacian $(-\Delta)^s$, $0 < s < 1$, converges to the Laplacian (up to a sign) as $s \to 1^-$. In recent years, there has been some success in proving classical identities in geometry by first proving a fractional analogue and then sending $s \to 1^-$. Interestingly, the proof of these identities in the fractional framework often follows from a simple algebraic manipulation.
In this presentation, we will discuss some recent results in this direction including a new proof of the celebrated Bochner's formula on Riemannian manifolds and, if time permits, Simons' identity which we obtain via fractional methods. We prove fractional analogues of both of these identities as well as introduce a notion of fractional Ricci curvature on graphs.

TUSHIR, ABHILASH. DISCRETE HEAT EQUATION WITH IRREGULAR THERMAL CONDUCTIVITY AND TEMPERED DISTRIBUTIONAL DATA
Speaker: ABHILASH TUSHIR (None)
Time: 17:00 Wed 6 December
Place(s): 08-257
Author(s): MARIANNA CHATZAKOU, APARAJITA DASGUPTA, MICHAEL RUZHANSKY, AND ABHILASH TUSHIR
In this paper, we consider a semi-classical version of the nonhomogeneous heat equation with singular time-dependent coefficients on the lattice $\hbar\mathbb{Z}^n$. We establish the well-posedeness of such Cauchy problems in the classical sense when regular coefficients are considered, and analyse how the notion of very weak solution adapts in such equations when distributional coefficients are regarded. We prove the well-posedness of both the classical and the very weak solution in the weighted spaces $\ell^2_s(\hbar\mathbb{Z}^n)$, $s \in \mathbb{R}$, which is enough to prove the well-posedness in the space of tempered distributions $\mathcal{S}'(\hbar\mathbb{Z}^n)$. Notably, when $s = 0$, we show that for $\hbar \to 0$, the classical (resp. very weak) solution of the heat equation in the Euclidean setting $\mathbb{R}^n$ is recaptured by the classical (resp. very weak) solution of it in the semi-classical setting $\hbar\mathbb{Z}^n$.

Wang, Rong. Long-time dynamics of an diffusive epidemic model with free boundaries
Speaker: Rong Wang (The Australian National University)
Time: 15:00 Thu 7 December
Place(s): 08-257
Author(s): Rong Wang, Yihong Du and Wenjie Ni
We consider the long-time dynamics of an epidemic model whose diffusion and reaction terms involve nonlocal effects described by suitable convolution operators, and the epidemic region is represented by an evolving interval enclosed by the free boundaries in the model. We show that this model is well-posed, and their long-time dynamical behaviours are characterized by a spreading-vanishing

dichotomy. When spreading persists, we determine the spreading speed and find a threshold condition in terms of the kernel functions appearing in the nonlocal diffusion terms, such that the spreading speed is finite precisely when this condition is satisfied; when this condition is not satisfied, we show that the spreading speed is infinite, namely accelerated spreading happens. For some typical classes of kernel functions, we determine the precise rate of accelerated expansion of the epidemic region by constructing delicate upper and lower solutions. This talk is based on joint works with Professor Yihong Du and Dr. Wenjie Ni.

Wheeler, Glen Edward. The Entropy Flow
Speaker: Glen Edward Wheeler (University of Wollongong)
Time: 16:00 Fri 8 December
Place(s): 08-257
Author(s): Glen Wheeler

Hamilton's entropy is the quantity $\int k \log k \, ds = \int \log k d\theta$. It has been classically used in the analysis of curve shortening flow. Later it was also used in the analysis of more general flows, where it plays a decisive role. In this talk, we study the $L^2(d\theta)$-gradient flow for the entropy. This is a fourth-order curvature flow that is well-defined on convex curves. The flow is remarkably well-behaved compared to other fourth-order flows such as the curve diffusion or Chen flows. We can show that the flow exists from rough initial data, exists for all time, and (in a rescaling) converges to a round, possibly multiply-covered circle. This is joint work with Valentina Wheeler and Lachlann O'Donnell.

Zhu, Ruixuan. Parabolic Monge-Ampère equations without concavity
Speaker: Ruixuan Zhu (Australian National University)
Time: 16:30 Wed 6 December
Place(s): 08-257
Author(s): Yang Zhou, Ruixuan Zhu

The initial-boundary value problem for the parabolic Monge-Ampère equation is a fundamental and important issue, which can be derived from the Gauss curvature flow with boundaries. The existence and $C^{2,\alpha}$ regularity for solutions of this equation have remained unresolved. The main difficulty arises from the inherent lack of concavity of the equation. In this presentation, we will prove the a priori $C^{2,\alpha}$ estimates for the equation. To address the non-concavity, we employ a duality method to derive a new concave equation, along with a specific technique adapted from linear elliptic equations to establish the boundary estimate.

18. Probability and Mathematical Statistics

Collevecchio, Andrea. Localization of Vertex Reiinforced Jump Processes
Speaker: Andrea Collevecchio (Monash University)
Time: 14:00 Tue 5 December
Place(s): 03-320
Author(s): Andrea Collevecchio

We study the behaviour of Vertex Reinforced Jump Processes on general graph, in the strongly reinforcement regime. We prove that the set of vertices that are visited infinitely often is a star shaped subgraph, and only one vertex accumulates unbounded local time.
Joint works with Tuan-Minh Nguyen and Stas Volkov

De Livera, Alysha. Multivariate meta-analysis methods for high-dimensional data
Speaker: Alysha De Livera (La Trobe University)
Time: 15:00 Fri 8 December
Place(s): 03-320
Author(s): Alysha De Livera, Jayamini Liyanage, Luke Prendergast

Meta-analysis is a statistical method that combines quantitative results from multiple independent studies on a particular research question or hypothesis, with the goal of making inference about the population effect size of interest. Traditional meta-analysis methods have focused on combining results from multiple independent studies, each of which has measured an effect size associated with a single outcome of interest. Modern studies in evidence synthesis, such as those in biological studies have focused on combining results from studies which have measured multiple effect sizes associated with multiple correlated outcomes. This presentation will introduce multivariate meta-analysis methods

for obtaining summary estimates of the effect sizes of interest for high-dimensional data, and describe the statistical challenges in doing so, with applications to real and simulated high-dimensional data.

Donhauzer, Illia. Limit theorems for multifractal products of random fields
Speaker: Illia Donhauzer (La Trobe University)
Time: 16:00 Wed 6 December
Place(s): 03-320
Author(s): Illia Donhauzer

The talk is about asymptotic properties of multifractal products of random fields and multidimensional multifractal measures. The obtained limit theorems provide sufficient conditions for the convergence of cumulative fields in the spaces Lq. New results on the rate of convergence of cumulative fields will be presented. Simple unified conditions for the limit theorems and the calculation of the Renyi function are given. They are less restrictive than those in the known one-dimensional results. The developed methodology is also applied to multidimensional multifractal measures.
References: Donhauzer, I., and Olenko, A. (2023). Limit theorems for multifractal products of random fields, Journal of Mathematical Analysis and Applications, 127888, https://doi.org/10.1016/j.jmaa.2023.127888.

Feng, Renjie. A graphical formula for cumulants of multivariate linear statistics of determinantal point processes.
Speaker: Renjie Feng (The University of Sydney)
Time: 16:30 Fri 8 December
Place(s): 03-320
Author(s): Renjie Feng

In this talk, I will derive a formula for cumulants of multivariate linear statistics of DPPs in terms of graph, this formula extends the famous Soshnikov's formula for the univariate case. As an application, for the harmonic ensembles, the multivariate linear statistics admit the first and second Wiener chaos.

Field, Laurence. Brownian motion and permeable boundaries
Speaker: Laurence Field (Australian National University)
Time: 15:00 Tue 5 December
Place(s): 03-320
Author(s): Laurence Field

We review the Brownian excursion measure and its relation to classical conformal invariants such as extremal distance by choice of appropriate boundary conditions. We extend the discussion of boundary conditions to allow various combinations of absorbing, reflecting and permeable boundaries on different boundary segments and describe the corresponding synthetic Brownian motion processes and conformal mappings.

Geng, Xi. Expected signature on Riemannian manifolds and its geometric implications
Speaker: Xi Geng (The University of Melbourne)
Time: 14:00 Wed 6 December
Place(s): 03-320
Author(s): Xi Geng

In this talk, we establish the intrinsic PDE for the expected signature dynamics of Brownian motion and Brownian bridge on a Riemannian manifold. Through a natural asymptotic procedure, we show that the expected signature of Brownian bridge can be used to reconstruct the Riemannian distance function. This inversion mechanism has a close connection with the (deterministic) length conjecture in rough path theory, which asserts that the length of a tree-reduced BV path can be recovered from its normalised signature asymptotics. This talk is based on an ongoing project with H. Ni (UCL), C. Wang (Bath) as well as previous joint work with H. Boedihardjo (Warwick).

Goodman, Jesse. Splitting the saddlepoint approximation across a sample path
Speaker: Jesse Goodman (University of Auckland)
Time: 14:00 Fri 8 December
Place(s): 03-320
Author(s): Jesse Goodman

For a given random variable or random vector, we often need a simpler approximation to its probability mass or density function based on partial information. The saddlepoint approximation is one such technique, producing a high-quality approximation using only the values of the moment generating function and its first two derivatives.
When our random vector is the sample path of a Markov chain, we have two options: we can approximate the correlated multivariate distribution directly; or we can factor across steps using the Markov property and use a product of univariate approximations to each transition probability. Typically, these two approaches will yield different approximations. However, for a recursively compounded process (a class that includes branching processes and compound Poisson processes) the saddlepoint approximation yields identically equal results. This talk will outline the "tilting" interpretation of the saddlepoint approximation and show how this implies the proof.

Hamza, Kais. A deterministic walk on the randomly oriented Manhattan lattice
Speaker: Kais Hamza (Monash University)
Time: 13:30 Tue 5 December
Place(s): 03-320
Author(s): Andrea Collevecchio, Kais Hamza and Laurent Tournier

Consider a randomly-oriented two dimensional Manhattan lattice where each horizontal line and each vertical line is assigned, once and for all, a random direction by flipping independent and identically distributed coins. A deterministic walk is then started at the origin and at each step moves diagonally to the nearest vertex in the direction of the horizontal and vertical lines of the present location. This definition can be generalized, in a natural way, to larger dimensions, but we mainly focus on the two dimensional case. In this context the process localizes on two vertices at all large times, almost surely. We also provide estimates for the tail of the length of paths, when the walk is defined on the two dimensional lattice. In particular, the probability of the path to be larger than n decays sub-exponentially in n. It is easy to show that higher dimensional paths may not localize on two vertices but will still eventually become periodic, and are therefore bounded.

Harris, Simon. Genealogies of samples from stochastic population models
Speaker: Simon Harris (University of Auckland)
Time: 14:30 Tue 5 December
Place(s): 03-320
Author(s): Simon C. Harris

What does the family tree look like for a random sample of k individuals taken from some population? Surprisingly, until recently this fundamental question remained an open problem even for one of the simplest of stochastic population models. We will discuss some recent progress in probability theory here, including the emergence of certain universal limiting genealogies when sampling individuals at random from large stochastically evolving populations, such as critical Galton-Watson stochastic branching processes conditioned to survive. Some ongoing work and open problems will also be mentioned.

Krupskiy, Pavel. Max-convolution processes with random shape indicator kernels
Speaker: Pavel Krupskiy (The University of Melbourne)
Time: 14:30 Fri 8 December
Place(s): 03-320
Author(s): Pavel Krupskiy, Raphael Huser

In this paper, we introduce a new class of models for spatial data obtained from max-convolution processes based on indicator kernels with random shape. We show that this class of models have appealing dependence properties including tail dependence at short distances and independence at long distances. We further consider max-convolutions between such processes and processes with tail independence, in order to separately control the bulk and tail dependence behaviors, and to increase flexibility of the model at longer distances, in particular, to capture intermediate tail dependence. We show how parameters can be estimated using a weighted pairwise likelihood approach, and we conduct an extensive simulation study to show that the proposed inference approach is feasible in high dimensions and it yields accurate parameter estimates in most cases. We apply the proposed methodology to analyse daily temperature maxima measured at 100 monitoring stations in the state of Oklahoma, US. Our results indicate that our proposed model provides a good fit to the data, and that it captures both the bulk and the tail dependence structures accurately.

Maller, Ross. Asymptotics of the Allele Frequency Spectrum and the Number of Alleles
Speaker: Ross Maller (Australian National University)
Time: 13:30 Wed 6 December
Place(s): 03-320
Author(s): Ross Maller and Soudabeh Shemehsavar

We derive large-sample distributions of components of the allele frequency spectrum vector, M_n, joint with the number of alleles, K_n, from a sample of n genes. Models analysed include those constructed from gamma and α-stable subordinators by Kingman (thus, including the Ewens sampling formula), two-parameter extension by Pitman and Yor, and two-parameter version constructed by omitting large jumps from an α-stable subordinator.
In each case the limiting distribution of a finite number of components of M_n is derived, joint with K_n. New results include that in the Poisson-Dirichlet case, M_n and K_n are asymptotically independent after centering and norming for K_n, and notable is that in other cases the limiting distribution of a finite number of components of M_n, after centering and an unusual $n^{\alpha/2}$ norming, conditional on that of K_n, is normal.

McLachlan, Geoffrey. A Surprising Result in Semi-Supervised Learning
Speaker: Geoffrey McLachlan (The University of Queensland)
Time: 13:30 Fri 8 December
Place(s): 03-320
Author(s): Geoffrey J. McLachlan

As is well known, the (Fisher) information in an unclassified feature with unknown class label is less (considerably less for weakly separated classes) than that of a classified feature which has known class label. Hence in the case where the absence of class labels does not depend on the data, the expected error rate of a classifier formed from the classified and unclassified features in a partially classified sample can be relatively much greater than that if the sample were completely classified. On treating the labels of the unclassified features as missing data and adopting a framework for their missingness, it is shown that the performance of the Bayes' classifier can be improved to an extent where the SSL rule so produced can outperform the rule based on the sample if it were completely classified. This is a most surprising result. It can occur in situations where the unclassified features tend to fall in overlapping regions of the classes in the feature space; that is, for features that are difficult to classify. Such features tend to have relatively high entropy and so it is proposed that the probability a class label is missing be modelled as a function of the entropy of the associated feature vector. This is joint work with Daniel Ahfock.

Menesch, Joseph. Automated importance function estimation for adaptive multilevel splitting
Speaker: Joseph Menesch (The University of Queensland)
Time: 17:00 Wed 6 December
Place(s): 03-320
Author(s): Joseph Menesch, Thomas Taimre, Slava Vaisman, Krzysztof Bisewski

Consider the small probability that a diffusion process parameterized by its noise level hits a particular set before another. For the estimation of this rare-event probability, adaptive multilevel splitting (AMS) is well-suited due to its practicality and desirable properties. However, it requires an importance function (IF), whose choice determines the algorithm's efficiency. The optimal IF for AMS is the committor function, which is generally not known nor easily guessed. We propose an iterative heuristic, called AutoIF, which is motivated by the observation that AMS efficiently generates an ensemble of points which can be utilized in solving the problem. For AutoIF, a sequence of modified, increasingly rare problems are solved via AMS, and the resulting ensemble is used to approximate a new IF for the next iteration via some function approximation method – in our case, a cell-based method and logistic regression. The final IF is used to estimate the target probability. A gradual approximation of IFs for rarer and rarer problems eventually leads to an IF for the target problem which may provide a better approximation of the committor function than one which is approximated outright. We compared AutoIF against ordinary AMS (using typical user-defined IF) on three problem-types – an Ornstein-Uhlenbeck spiral, three-wells potential, and rugged Mueller potential – across three rarity levels and up to dimension 10. AutoIF generally had lower relative error than AMS for rarer problems, but the function approximation method became a hindrance in higher dimensions. The cell method often outperformed logistic regression, but struggled with numerical issues. Furthermore, AutoIF performed best for the spiral and the three-wells problems. Overall, we found that AutoIF is strongest in rarer problems that have complex dynamics, making it a promising choice for

rare-event problems which are out of reach for traditional algorithms. Possible improvements could include better function approximation methods.

Muirhead, Stephen. Persistence of stationary Gaussian fields with spectral singularity
Speaker: Stephen Muirhead (The University of Melbourne)
Time: 14:30 Wed 6 December
Place(s): 03-320
Author(s): Stephen Muirhead

We consider the probability that a stationary Gaussian field stays positive on a large ball $B(T)$. Our main result is that, if the field has a spectral singularity at the origin of order $\alpha \in (0, d)$ (as well as certain mild regularity conditions), this probability decays at log-asymptotic rate $m(d-\alpha)(\log T)\kappa(B(T))$, where $\kappa(B(T))$ is the capacity of $B(T)$ with respect to the field, and m is the mass of the absolutely continuous component of its spectrum.
We also derive related 'entropic repulsion' estimates for the field conditioned to persist, showing roughly that the conditioned field fluctuates around $m(d-\alpha)(\log T)h_{B(T)}$, where $h_{B(T)}$ is the equilibrium potential of $B(T)$.
If the spectral singularity is regularly varying, our results have more precise formulations in terms of the capacity and equilibrium potential of the α-Riesz kernel; this demonstrates the universality of persistence in the presence of a regularly varying spectral singularity.
Joint work with Naomi Feldheim and Ohad Feldheim.

Nam, Kihun. Coupled FBSDEs with Measurable Coefficients and its Application to Parabolic PDEs
Speaker: Kihun Nam (Monash University)
Time: 14:30 Thu 7 December
Place(s): 03-320
Author(s): Kihun Nam, Yunxi Xu

Using purely probabilistic methods, we prove the existence and the uniqueness of solutions for a system of coupled forward-backward stochastic differential equations (FBSDEs) with measurable, possibly discontinuous, coefficients. As a corollary, we obtain the well-posedness of semilinear parabolic partial differential equations (PDEs)

$$\mathcal{L}u(t,x) + F(t,x,u,\partial_x u) = 0; \qquad u(T,x) = h(x)$$

in the natural domain of the second-order linear parabolic operator $\mathcal{L}$ when F and h are not necessarily continuous with respect to x. We also provide a sufficient condition for this solution to be in a Sobolev space.

Olenko, Andriy. On Fractional Spherically Restricted Hyperbolic Diffusion Random Field
Speaker: Andriy Olenko (La Trobe University)
Time: 15:00 Wed 6 December
Place(s): 03-320
Author(s): A.Olenko

We will discuss the fractional hyperbolic diffusion equation in its most general form with two fractional derivatives of distinct orders. The solutions are given as spatial-temporal homogeneous and isotropic random fields and their spherical restrictions are studied. The spectral representations of these fields are derived and the associated angular spectrum is analysed. The obtained mathematical results are illustrated by numerical examples. In addition, the numerical investigations assess the dependence of the covariance structure and other properties of these fields on the orders of fractional derivatives.
The presentation is based on joint results with N.Leonenko (Cardiff University, UK) and J.Vaz (University of Campinas, Brazil).

Perez, Aram. Stein's Method in Statistical Mechanics
Speaker: Aram Perez (Monash University)
Time: 17:00 Tue 5 December
Place(s): 03-320
Author(s): Aram Perez

Stein's Method is a powerful tool for studying distances between distributions of random variables. It has been used widely in the context of statistical mechanics to obtain appropriate approximations of various thermodynamic quantities. We will discuss an application of Stein's Method to the O(N) model, a model of magnetism, and show how recent advances in the theory allow us to study its limiting behaviour at the phase transition.

Sofronova, Ksenia. Optimal Sequential Decisions with Financial Applications
Speaker: Ksenia Sofronova (UNSW Sydney)
Time: 16:30 Wed 6 December
Place(s): 03-320
Author(s): Ksenia Sofronova

In many financial applications, data is sequentially collected over time, and it is necessary to make decisions based on already obtained information while future observations are not seen yet. From a mathematical point of view, a decision-maker observes a sequence of random variables and must decide when to stop, given that there is no recall allowed. In other words, once a random variable is rejected, it cannot be chosen later on. The decision to stop depends only on the observations already made but does not depend on the future which is not yet known. The objective is to find an optimal procedure that maximizes an expected gain. Here we will consider problems when multiple stops are required, for example, a sequential problem of selling several identical assets over a finite time horizon.

Taylor, Peter Gerrard. A General Framework for Modelling Hypnozoite Accrual and Superinfection in Malaria
Speaker: Peter Gerrard Taylor (The University of Melbourne)
Time: 13:30 Thu 7 December
Place(s): 03-320
Author(s): Somya Mehra, James McCaw and Peter Taylor

We present a model of hypnozoite accrual and superinfection for malaria. We first analyse a continuous-time Markov chain model for the within-host evolution of infection following a bite from an infected mosquito.
We then consider a population-level differential equation compartmental model for the number of individuals in the different infection states that can be derived (i) as a functional law of large numbers of a stochastic model, (ii) as modelling the evolution of the expected number of individuals in each infection state or (iii) as a standard compartmental model of the type that is commonly written down in mathematical biology.
Recognising that the subset of these equations that model the infection status of the human hosts has precisely the same form as the Kolmogorov forward equations for a Markovian network of infinite server queues evolving according to the within host model, we use physical insight into the evolution of the latter process to write down a time-dependent multivariate generating function for the solution. We use this characterisation to collapse the compartmental model into a single integrodifferential equation (IDE) governing the intensity of mosquito-to-human transmission. Through a steady state analysis, we recover a threshold phenomenon for this IDE in terms of a parameter R_0 expressible in terms of the primitives of the model, with the disease-free equilibrium shown to be uniformly asymptotically stable if $R_0 < 1$ and an endemic equilibrium solution emerging if $R_0 > 1$.

Warne, David James. Multidelity multilevel Monte Carlo for approximate Bayesian computation
Speaker: David James Warne (Queensland University of Technology)
Time: 16:00 Fri 8 December
Place(s): 03-320
Author(s): David J. Warne, Thomas P. Prescott, Ruth E. Baker, Matthew J. Simpson

Models of stochastic processes are widely used in almost all fields of science. However, data are almost always incomplete observations of reality. This leads to a great challenge for statistical inference because the likelihood function will be intractable for almost all partially observed stochastic processes. As a result, it is common to apply likelihood-free approaches that replace likelihood evaluations with realisations of the model and observation process. However, likelihood-free techniques are computationally expensive for accurate inference as they may require millions of high-fidelity, expensive stochastic simulations.
To address this challenge, we develop a new method based on recent advances in the class of methods for estimation of expectations with respect to posterior distributions for parameter inference with partially observed Markov processes models. Our novel approach combines the multilevel Monte Carlo telescoping summation, applied to a sequence of approximate Bayesian posterior targets, with a multifidelity rejection sampler that learns from low-fidelity, computationally inexpensive, model approximations to minimise the number of high-fidelity, computationally expensive, simulations required for accurate inference. Using examples from systems biology, we demonstrate improvements of more than two orders of magnitude over standard rejection sampling techniques.

wu, binghao. The derivative of Brownian motion localtimes
Speaker: binghao wu (None)
Time: 16:30 Tue 5 December
Place(s): 03-320
Author(s): Binghao Wu

Numerous studies have delved into the intricacies of Brownian motion local times. Berman explored the existence of these processes, a topic further validated by the application of the Tanaka formula. This class of processes bears significant relevance to the realm of physics and Parabolic Anderson models, necessitating an understanding of exponential integrability. Scholars such as Le Gall, Bass, and Chen have diligently investigated these themes, while the derivative of these processes piqued scholarly interest later on. The existence of the derivative was rigorously established by Rosen and Markowsky. However, despite the extensive research, the question of exponential integrability of these processes remains relatively unexplored. Consequently, this study primarily focuses on unraveling the exponential integrability aspects concerning the derivative of intersection local times of Brownian motions. Moreover, the scope of our analysis extends to encompass symmetric stable processes, broadening the applicability of our findings.

Xia, Aihua. On the rate of normal approximation for Poisson continuum percolation
Speaker: Aihua Xia (The University of Melbourne)
Time: 14:00 Thu 7 December
Place(s): 03-320
Author(s): Aihua Xia

Poisson continuum percolation has been of considerable interest for decades, and it is well known that the number of points in the largest cluster of a percolating Poisson process in $\mathbb{R}^m$ restricted to the box $[-n, n]^m$ is asymptotically normal as $n \to \infty$. As the largest cluster is determined by points as far as the diameter of the box, there is long-range dependence of the points in the largest cluster, hence known results in the literature of normal approximation for Poisson functionals cannot be directly applied. To disentangle the long-range dependence of the largest cluster, we use the fact that the second largest cluster has comparatively shorter range of dependence to restrict the range of dependence, apply a recently established result in [Chen, Röllin and Xia (2021)] to obtain a Berry-Esseen type bound for the normal approximation of the number of points belonging to clusters that have a restricted range of dependence, and then estimate the gap between this quantity and the number of points in the largest cluster. (Based on a joint work with Tiffany Y. Y. Lo.)

Yamazaki, Kazutoshi. Lévy bandits under Poissonian decision times
Speaker: Kazutoshi Yamazaki (The University of Queensland)
Time: 17:00 Fri 8 December
Place(s): 03-320
Author(s): Jose Luis Perez, Kazutoshi Yamazaki

We consider a version of the continuous-time multi-armed bandit problem where decision opportunities arrive at Poisson arrival times, and study its Gittins index policy. When driven by spectrally one-sided Lévy processes, the Gittins index can be written explicitly in terms of the scale function, and is shown to converge to that in the classical Lévy bandit of Kaspi and Mandelbaum (1995).

Zang, Zehua. Branching processes with detection
Speaker: Zehua Zang (The University of Auckland)
Time: 16:00 Tue 5 December
Place(s): 03-320
Author(s): Zehua Zang

Over the years, predicting the size of population outbreaks and assessing the effectiveness of disease control measures have been prominent challenges in epidemiology. A common approach to address these issues involves mathematical modelling using stochastic processes. Within this field, the detection problem presents a significant hurdle. In real-world scenarios, the size of disease clusters is influenced by the level of quarantine, which corresponds to the detection rate. A higher detection rate, indicative of a more rigorous quarantine, increases the likelihood of identifying diseases in their early stages and subsequently helps control the size of disease clusters during an outbreak. This study delves into the behaviour of infection spread in the context of detection problems, employing a modern probabilistic way.

19. Stochastic Differential Equations

Fan, Jie Yen. Measure-valued processes and stochastic partial differential equations
Speaker: Jie Yen Fan (Monash University)
Time: 14:00 Fri 8 December
Place(s): 03-315
Author(s): Jie Yen Fan

Measure-valued stochastic processes are very useful in describing the evolution of complex structural systems, such as in population modelling. We use measure-valued processes to study population structures that feature characteristics such as the population size, the individuals' ages, and other attributes; and where the dynamics depend on the whole population as well as each individual. Limiting behaviours in terms of Law of Large Numbers and Central Limit Theorem can be obtained in the form of PDE and SPDE, respectively. Although SPDEs arise in many areas, they are not well understood, even more so in our case, where the solutions of our SPDEs are distribution-valued. In this talk, some results associated with the SPDEs will be discussed. In particular, we give an Ito integral representation to the martingale term of the SPDE.

Feng, Zhewen. Existence of solutions to the stochastic Ericksen-Leslie system in a 3-D bounded domain
Speaker: Zhewen Feng (The University of Queensland)
Time: 16:30 Tue 5 December
Place(s): 03-315
Author(s): Zhewen Feng, Joseph F. Grotowski, Min-Chun Hong, Chris van der Heide

Motivated by experimental evidence on the effect of thermal fluctuations in liquid crystal flows, we consider the stochastic Ericksen-Leslie system with general Oseen-Frank energy in a three-dimensional bounded domain. Utilising the classical Ginzburg-Landau approach, we prove the convergence of solutions to the stochastic approximation and prove the existence of martingale solutions that are strong in the sense of PDEs up to a maximal existence time.

Goldys, Beniamin. Erika Hausenblas: A stochastic bidomain model with Gaussian and pure Levy noise, part II
Speaker: Beniamin Goldys (The University of Sydney)
Time: 14:00 Thu 7 December
Place(s): 03-315
Author(s): Beniamin Goldys

See abstract for part I.

Hausenblas, Erika. A stochastic bidomain model with Gaussian and pure Lévy noise
Speaker: Erika Hausenblas (Montanuniversitaet Leoben)
Time: 13:30 Thu 7 December
Place(s): 03-315
Author(s): Erika Hausenblas

The bidomain system of degenerate reaction–diffusion equations is a well-established spatial model of electrical activity in cardiac tissue, with *reactions* linked to the cellular action potential and *diffusion* representing current flow between cells. The bidomain equations result from the principle of conservation of current between the intra- and extracellular domains, followed by a homogenization process of the cellular model defined on a periodic structure of cardiac tissue. So, the bidomain model is a system of PDEs, consisting of a degenerate parabolic (reaction–diffusion) PDE for the transmembrane potential and an elliptic PDE for the extracellular potential.
In a joint work with Kenneth Karlsson (Oslo, Norway) and Kistosil Fahim (Surabaya, Indonesia), we considered a *the stochastically forced* version of the bidomain model that models various random effects. Here, we incorporated Wiener and Lévy noise, where the Lévy noise models the possibility of jumps in the current. The proof relies on a stochastic Schauder Theorem.

Jiao, Chunxi. On the thin-film limit of stochastic Landau-Lifshitz equation
Speaker: Chunxi Jiao (RWTH Aachen University)
Time: 14:00 Tue 5 December
Place(s): 03-315
Author(s): Chunxi Jiao and Thanh Tran

In the presence of a dominating stray field, it is known that the thin-film limit of the Landau-Lifshitz-Gilbert (LLG) equation under suitable scaling of parameters is effectively a damped wave equation. We study the extension of this result to the stochastic case, for which the Gilbert form involving time derivatives is no longer convenient and pathwise uniqueness is not available. We approach the problem by considering a regularised stochastic Landau-Lifshitz (sLLG) equation with additional bi-Laplacian terms, which admits a pathwise unique solution and converges weakly to the sLLG. Then the Doss-Sussmann transformation allows us to obtain Wong-Zakai type approximations for the regularised equations and subsequently solution of a perturbed LLG. Since the deterministic result can be applied directly to the latter, we show that the thin-film limit of sLLG can be approximated using solutions of perturbed wave equations. This talk is based on a joint work with Thanh Tran.

JIN, SHIJIA. Market making, FBSDE, and BSRE
Speaker: SHIJIA JIN (Monash University)
Time: 15:00 Tue 5 December
Place(s): 03-315
Author(s): SHIJIA JIN

We propose a stochastic game between market makers, where they compete for the order flow in the market. By the non-smooth analysis and stochastic maximum principle, the Nash equilibrium can be characterised by the solution of a multi-dimensional forward-backward stochastic differential equation (FBSDE). Extending the decoupling approach to the one-dimensional case, it turns out that the well-posedness of the multi-dimensional equation can be guaranteed by the existence of a unique bounded solution to the backward stochastic Riccati equation (BSRE).

Khan, Muhammad Awais. Numerical analysis of stochastic Stefan problem
Speaker: Muhammad Awais Khan (Monash University)
Time: 14:30 Tue 5 December
Place(s): 03-315
Author(s): Jerome Droniou, Muhammad Awais Khan, Kim Ngan Le

The gradient discretisation method (GDM) – a generic framework encompassing many numerical methods – is studied for a general stochastic Stefan problem with multiplicative noise. The convergence of the numerical solutions is proved by compactness method using discrete functional analysis tools, Skorohod theorem and the martingale representation theorem. The generic convergence results established in the GDM framework are applicable to a range of different numerical methods, including for example mass-lumped finite elements, but also some finite volume methods, mimetic methods, lowest-order virtual element methods, etc. Theoretical results are complemented by numerical tests based on two methods that fit in GDM framework.

Le, Ngan. Stochastic perturbation vs variance of solutions to stochastic PDEs
Speaker: Ngan Le (Monash University)
Time: 16:30 Fri 8 December
Place(s): 03-315
Author(s): Ngan Le

Based on the central limit theorem, it is well known that mean of a random variable can be approximated by using the Monte Carlo method with 1/2 order of convergence. The error estimate also depends on the variance of the random variable. In stochastic differential equations, how variance of the solution depends on the magnitude of the stochastic perturbation is an interesting question relating to estimate the expectation of solutions. In this talk, we will discuss the relationship of the noise intensity parameter and variance of $\phi(u)$, where u is a solution to stochastic nonlinear equations and ϕ is a real value function. Equations mentioned in this talks are the stochastic p-Laplace equations and the stochastic Landau-Lifshitf-Gilbert equations. This is a joint work with Beniamin Goldys.

Le Gia, Quoc Thong. Discretisation of a class of semilinear stochastic PDEs on the unit sphere and invariant measures
Speaker: Quoc Thong Le Gia (University of New South Wales)
Time: 13:30 Fri 8 December
Place(s): 03-315
Author(s): B. Goldys, Q. T. Le Gia, H. Wendland

In this work, we will consider the discretization of a class of semilinear stochastic partial differential equations on the unit sphere. The spatial discretization is carried out via the Galerkin methods using spherical radial basis functions while the time discretization is implemented by the Euler-Maruyama method. Error estimates and the existence of invariant measures of the discrete solutions will be discussed.

Li, Libo. Parametrix Method for Skew Diffusion and its Local Time
Speaker: Libo Li (University of New South Wales)
Time: 16:00 Tue 5 December
Place(s): 03-315
Author(s): Libo Li and Guanting Liu

We prove weak uniqueness for some path-dependent stochastic differential equations. More specifically, by applying the parametrix method, we study the marginal law of the skew diffusion process, with Holder continuous coefficients which can depend on its local time, and its local time. The existence of a transition density and corresponding density estimates are investigated.

Liu, Ruyi. Pairs Trading: An Optimal Selling Rule with Constraints
Speaker: Ruyi Liu (The University of Sydney)
Time: 14:30 Thu 7 December
Place(s): 03-315
Author(s): Ruyi Liu, Jingzhi Tie, Zhen Wu and Qing Zhang

The focus of this paper is on identifying the most effective selling strategy for pairs trading of stocks. In pairs trading, a long position is held in one stock while a short position is held in another. The goal is to determine the optimal time to sell the long position and repurchase the short position in order to close the pairs position. The paper presents an optimal pairs-trading selling rule with trading constraints. In particular, the underlying stock prices evolve according to a two-dimensional geometric Brownian motion, and the trading permission process is given in terms of a two-state trading allowed, trading not allowed Markov chain. It is shown that the optimal policy can be determined by a threshold curve which is obtained by solving the associated Hamilton-Jacobi-Bellman (HJB) equations (quasi-variational inequalities). A closed-form solution is obtained. A verification theorem is provided. Numerical experiments are also reported to demonstrate the optimal policies and value functions.

Mukherjee, Debopriya. A shape Calculus Approach for time harmonic solid - fluid interaction problem in stochastic domains
Speaker: Debopriya Mukherjee (Indian Institute of Technology Indore)
Time: 16:00 Fri 8 December
Place(s): 03-315
Author(s): Debopriya Mukherjee and Thanh Tran

The present paper deals with the interior solid - fluid interaction problem in harmonic regime with randomly perturbed boundaries. Analysis of the shape derivative and shape Hessian of vector- and tensor-valued functions is provided. Moments of the random solutions are approximated by those of the shape derivative and shape Hessian, and the approximations are of third order accuracy in terms of the size of the boundary perturbation. Our theoretical results are supported by an analytical example on a square domain.

Panda, Akash Ashirbad. Higher order time discretization for the stochastic semilinear wave equation with multiplicative noise
Speaker: Akash Ashirbad Panda (Indian Institute of Technology Bhubaneswar)
Time: 13:30 Tue 5 December
Place(s): 03-315
Author(s): Xiaobing Feng, Akash Ashirbad Panda, and Andreas Prohl

In the field of fluid dynamics, electromagnetics, and acoustics, the physical phenomena such as mechanical vibrations and wave motions are commonly observed. These phenomena are usually modelled by hyperbolic partial differential equations (PDEs). One of the examples of hyperbolic PDEs is the wave equation, which describes the propagation of variety of waves (e.g. water waves, sound waves, and seismic waves). In this talk, I will introduce a higher order time-discretized scheme, where the iterates approximate the solution of the stochastic semi-linear wave equation driven by multiplicative noise with general drift and diffusion. A variational method for its error analysis is employed and an

improved convergence order of $\frac{3}{2}$ for the approximates of the solution is obtained. I will also introduce another time-discretized scheme where the drift and diffusion depend on both position and velocity. The core of the analysis is Hölder continuity in time and moment bounds for the solutions of the continuous and the discrete problem. I will show several computational experiments that validate our results.

Wichmann, Jörn. A class of space-time discretizations for the stochastic p-Stokes system
Speaker: Jörn Wichmann (Monash University)
Time: 17:00 Tue 5 December
Place(s): 03-315
Author(s): Kim-Ngan Le, Jörn Wichmann

In this talk we propose a new class of space-time discretizations for the stochastic p-Stokes system and analyze its stability and convergence properties.
We derive regularity results for the approximation that are similar to the natural regularity of solutions. One of the key arguments relies on discrete extrapolation that allows to relate lower moments of discrete maximal processes.
We show that, if the generic spatial discretization is constraint conforming, then the velocity approximation satisfies a best-approximation property in the natural distance.
Moreover, we present an example such that the resulting velocity approximation converges with rate 1/2 in time and 1 in space towards the (unknown) target velocity with respect to the natural distance.

20. Representation Theory

Albion, Seamus. Littlewood's decomposition and character factorisations
Speaker: Seamus Albion (University of Vienna)
Time: 17:00 Tue 5 December
Place(s): 02-D114
Author(s): Seamus Albion

The Littlewood decomposition, which maps a partition to its r-core and r-quotient, first appeared in the modular representation theory of the symmetric group. As an application, Littlewood used his decomposition to compute the image of the Schur function under the action of a certain operator on symmetric functions which can be viewed as the adjoint of plethysm by a power sum p_r with respect to the usual Hall inner product. I will explain some recent generalisations of this result to the universal characters of the symplectic and orthogonal groups, and how the combinatorics of the Littlewood decomposition plays a role in these cases.

Coulembier, Kevin. N-spherical functors and tensor categories
Speaker: Kevin Coulembier (The University of Sydney)
Time: 13:30 Tue 5 December
Place(s): 02-D114
Author(s): Kevin Coulembier

Recently, Dyckerhoff, Kapranov and Schechtman introduced a notion of N-spherical functors of stable infinity categories, generalising the notion of spherical functors (as studied by Anno, Kuznetsov and others).
We apply this to the setting of tensor categories; calling an object N-bounded if the corresponding regular endofunctor on the derived category is N-spherical. Besides giving new examples of N-spherical functors, the notion of N-bounded objects gives surprising connections with Jones-Wenzl idempotents, Frobenius-Perron dimensions and the main conjectures in the field of symmetric tensor categories.
Based on joint work with Pavel Etingof.

Davis, Dougal. Unitary representations and localisation for Hodge modules
Speaker: Dougal Davis (The University of Melbourne)
Time: 14:00 Wed 6 December
Place(s): 02-D114
Author(s): Dougal Davis and Kari Vilonen

I will give an update on ongoing work (joint with Kari Vilonen) that aims to make progress towards the classification of unitary representations of real reductive Lie groups using tools from Hodge theory and algebraic geometry. Our most recent results are a version of Beilinson-Bernstein localisation for mixed Hodge modules, and a proof of a conjecture of Schmid and Vilonen that the resulting Hodge filtrations control the unitarity of real group representations. This talk is based on the preprint arXiv:2309.13215.

Fasquel, Justine. Building blocks for W-algebras
Speaker: Justine Fasquel (The University of Melbourne)
Time: 14:00 Thu 7 December
Place(s): 02-D114
Author(s): Justine Fasquel

W-algebras are a large family of vertex algebras associated to nilpotent orbits of simple Lie algebras. For classical Lie algebras, they are parametrized by certain partitions. Among the W-algebras of type $\mathfrak{sl}(n)$ those with nilpotent orbits corresponding to hook partitions $(m, 1, 1, \dots)$ of n are the most understood ones. In this talk, we will show that in fact any W-algebras of type $\mathfrak{sl}(n)$ should be expressed by using several hook-type W-algebras. We will illustrate with examples in small ranks.

Giannini, Stefano. Additive character varieties
Speaker: Stefano Giannini (The University of Queensland)
Time: 14:30 Wed 6 December
Place(s): 02-D114
Author(s): Stefano Giannini

We seek to understand the cohomology of character varieties associated to surface groups. These varieties have deep connections to various fields of mathematics and physics, including non-abelian Hodge theory, mirror symmetry, Yang-Mills theory, and the Langlands program. Understanding their geometry is therefore a fundamental problem. This project aims to shed light on these spaces by studying their additive counter parts.

Jakob, Konstantin. Stokes phenomenon of Kloosterman connections
Speaker: Konstantin Jakob (TU Darmstadt)
Time: 16:00 Wed 6 December
Place(s): 02-D114
Author(s): Andreas Hohl, Konstantin Jakob

Kloosterman sheaves for reductive groups were first constructed by Heinloth-Ngô-Yun using methods from the geometric Langlands program. Their de Rham analogues, also known as Frenkel-Gross connections, are algebraic connections on $\mathbb{C}^\times$ with a regular singularity at 0 and an irregular singularity at infinity. Irregular connections are subject to the Stokes phenomenon: the asymptotic behaviour of solutions can jump on sectors around the irregular singular point. This is encoded in the unipotent Stokes matrices, which are used to construct moduli spaces of irregular connections. I will outline how to use the Stokes phenomenon to prove uniqueness properties (physical rigidity) for Kloosterman connections.

Le, Ian. Cluster Structures on Braid Varieties
Speaker: Ian Le (Australian National University)
Time: 14:30 Thu 7 December
Place(s): 02-D114
Author(s): Ian Le

Braid varieties are configuration spaces of flags that naturally arise in many different areas–quantum groups, Legendrian links, mirror symmetry. I will explain how to construct cluster structures on these varieties using weaves, a degenerate version of Soergel calculus.

Li, Yau Wing. Endoscopy for affine Hecke categories
Speaker: Yau Wing Li (The University of Melbourne)
Time: 13:30 Wed 6 December
Place(s): 02-D114
Author(s): Yau Wing Li

Affine Hecke categories are categorifications of Iwahori-Hecke algebras, which are essential in the classification of irreducible representations of loop group LG with Iwahori-fixed vectors. The affine Hecke category has a monodromic counterpart, which contains sheaves with prescribed monodromy under the left and right actions of the maximal torus. We show that the neutral block of this monoidal category is equivalent to the neutral block of the affine Hecke category (with trivial torus monodromy) for the endoscopic group H. It is consistent with the Langlands functoriality conjecture.

Little, Eloise. Using alcove path combinatorics to identify Kazhdan-Lusztig cells
Speaker: Eloise Little (The University of Sydney)
Time: 16:30 Tue 5 December
Place(s): 02-D114
Author(s): Eloise Little

In this talk I will introduce the notion of positively folded alcove paths as a combinatorial approach to realise particular Kazhdan-Lusztig cells of an affine Coxeter group W.
Associating W to alcoves, one can define a subset of these alcoves associated to a subset of the generators of W. Restricting walks to be within this subset and positively folding realises a formula for the matrix entries of particular representations of the Hecke algebra associated to W.
The aim of this talk is to describe these particular walks, with examples.
This is joint work with Nathan Chapelier, Jeremie Guilhot and James Parkinson.

McNamara, Peter. The Spin Brauer Category
Speaker: Peter McNamara (The University of Melbourne)
Time: 14:00 Fri 8 December
Place(s): 02-D114
Author(s): Peter McNamara

We talk about a generalisation of the Brauer category that includes the spin representation and study its properties. Since the spin representation is a tensor generator of the category of finite dimensional modules of the special orthogonal Lie algebra, this allows us to see all of the representations.

Milicic, Dragan. A formula for n-homology and its application
Speaker: Dragan Milicic (None)
Time: 17:00 Wed 6 December
Place(s): 02-D114
Author(s): Dragan Milicic

We shall explain a simple formula for n-homology of modules over the enveloping algebra of a semisimple Lie algebra in terms of their localization. As an application we shall discuss the formula for n-homology of discrete series due to Wilfried Schmid.

Ryder, Jackson. Noncommutative affine curves and regular representations of affine Dynkin graphs
Speaker: Jackson Ryder (UNSW Sydney)
Time: 14:30 Tue 5 December
Place(s): 02-D114
Author(s): Jackson Ryder

In this talk we discuss certain affine open subsets of noncommutative $\mathbb{P}^1$s which arise in the study of noncommutative $\mathbb{P}^1$-bundles. We will discuss their construction and interesting properties, as well as a particularly nice connection with the representation theory of affine Dynkin graphs.

Scrimshaw, Travis. Representations of twisted quantum Clifford algebras
Speaker: Travis Scrimshaw (Hokkaido University)
Time: 14:30 Fri 8 December
Place(s): 02-D114
Author(s): Willie Aboumrad, Travis Scrimshaw

In this talk, we define a generalization $Cl_q(n,k)$ of the q-Clifford algebra introduced by Hayashi in 1990 as an intermediary to constructing representations of quantum groups. We construct a basis for $Cl_q(n,k)$ through a PBW-type basis, construct its center, classify when it is semisimple, and classify its simple modules.

Sherman, Alexander. Sylow subgroups of supergroups
Speaker: Alexander Sherman (The University of Sydney)
Time: 16:00 Tue 5 December
Place(s): 02-D114
Author(s): V. Serganova, A. Sherman, and D. Vaintrob

We give a report on an ongoing project to define analogues of Sylow subgroups of supergroups. In particular we explain for important supergroups what these Sylow subgroups are, and when we have uniqueness up to conjugacy.

Whitbread, Bailey. Polynomials in the variable q
Speaker: Bailey Whitbread (The University of Queensland)
Time: 15:00 Wed 6 December
Place(s): 02-D114
Author(s): Bailey Whitbread

To "study" a space can mean many things. For me, it begins by writing down a polynomial in the variable q and reading its features. Old mathematics tells us that these polynomials contain useful invariants of the space (eg. dimension, Euler characteristic, number of components). We will see new results regarding the geometry and topology of character varieties in arbitrary type. This extends the celebrated work of Hausel, Letellier and Rodriguez-Villegas.

Wijesena, Dilshan. Classifying representations of the Thompson groups and the Cuntz algebra
Speaker: Dilshan Wijesena (University of New South Wales)
Time: 16:30 Wed 6 December
Place(s): 02-D114
Author(s): Dilshan Wijesena, Arnaud Brothier

Richard Thompson's groups F, T and V are one of the most remarkable discrete infinite groups for their several unusual properties. On the other hand, the celebrated Cuntz algebra has many fascinating properties and it is known that V embeds inside the Cuntz algebra. However, classifying the representations of the Thompson groups and the Cuntz algebra have proven to be very difficult. Luckily, thanks to the novel technology of Vaughan Jones, a rich family of so-called Pythagorean representation of the Thompson groups and the Cuntz algebra can be constructed by simply specifying a pair of finite-dimensional operators satisfying a certain equality. These representations carry a powerful diagrammatic calculus which we use to develop techniques to study their properties. This permits to reduce very difficult questions concerning irreducibility and equivalence of infinite-dimensional representations into problems in finite-dimensional linear algebra. Moreover, we introduce the Pythagorean dimension which is a new invariant for all representations of the Cuntz algebra. For each dimension d, we show the irreducible classes form a moduli space of a real manifold of dimension $2d^2+1$. Finally, we introduce a tensor product for representations of the Cuntz algebra.

Williamson, Geordie. 4-Strand Burau is Unfaithful Modulo 5
Speaker: Geordie Williamson (None)
Time: 15:00 Thu 7 December
Place(s): 02-D114
Author(s): Joel Gibson, Geordie Williamson and Oded Yacobi

I'll report on recent work with Yacobi and Gibson where we find kernel elements in the reduction modulo 5 of the 4-strand Burau representation. (The faithfulness of this representation over Z is a notorious open problem.) Kernel elements modulo 2 and 3 were discovered in the 90s, but these are the first new kernel elements discovered in 25 years. The method uses reservoir sampling, a simple and beautiful technique with origins in computer science.

Zhu, Jieru. M-diagram bases of the Specht module for three row partitions
Speaker: Jieru Zhu (None)
Time: 13:30 Thu 7 December
Place(s): 02-D114
Author(s): Jieru Zhu

Specht modules are irreducible modules for the symmetric groups, and they admit a classical construction via standard Young tableaux and polytabloids. With a view towards Lie theory, $\mathfrak{sl}_3$-tensor invariants in $\mathbb{C}^{\mathbb{1}\mathbb{1}\otimes 3n}$ also form the Specht module associated to the cycle type (n, n, n). This module has a basis called $\mathfrak{sl}_3$-spiders, or webs, first invented by Kuperberg. Various bases and conjectures were formulated using webs. In this project, we construct a new basis, called M-diagram basis, motivated by a set of diagrams proposed by Tymoczko. We show that they admit a unitriangular base change to several known bases, such as the polytabloid basis, the reduced non-elliptic web basis, and the dual-canonical basis.

Šipka, Gavrilo. Yangians: their truncations and representation theory
Speaker: Gavrilo Šipka (The University of Queensland)
Time: 15:00 Tue 5 December
Place(s): 02-D114
Author(s): Gavrilo Šipka

To each classical Lie algebra $\mathfrak{g}$, one can associate an infinite-dimensional Hopf algebra $(X(\mathfrak{g}))$ $Y(\mathfrak{g})$ known as the (extended) Yangian of $\mathfrak{g}$. If we further quotient out by generators of "certain orders", we obtain a sub-algebra known as the truncated (extended) Yangian of order p. In type A, the truncation at the first order simply results in the enveloping algebra $(U(\mathfrak{gl}_N))$ $U(\mathfrak{sl}_N)$. Consequently, when one looks at the finite-dimensional irreducible representations of the corresponding (extended) Yangians, they can be described relatively efficiently in terms of the underlying Lie algebra representations. Unsurprisingly, for types B, C and D, this picture becomes more complicated and it is no longer sufficient to consider the truncation at the first order to describe the representation theory of the associated (extended) Yangians. In this talk, we will review the results in type A, and examine what occurs in the orthogonal cases (types B and D).

21. Topology

Anagnostou, Lukas. Weil-Petersson volumes, stability conditions and wall-crossing
Speaker: Lukas Anagnostou (The University of Melbourne)
Time: 16:30 Wed 6 December
Place(s): 01-E215
Author(s): Lukas Anagnostou, Scott Mullane and Paul Norbury

In this talk we discuss Weil-Petersson volumes of the moduli spaces of conical hyperbolic surfaces. The moduli spaces are parametrised by their cone angles which naturally live inside Hassett's space of stability conditions on nodal curves. Such stability conditions produce weighted pointed stable curves which define compactifications of the moduli space of curves generalising the Deligne-Mumford compactification. The space of stability conditions decomposes into chambers separated by walls. We assign to each chamber a polynomial corresponding to the Weil-Petersson volume of a moduli space of conical hyperbolic surfaces. The chambers are naturally partially ordered and the maximal chamber is assigned Mirzakhani's polynomial. We present a formula for wall-crossing polynomials, which relates the polynomial on any chamber to Mirzakhani's polynomial via wall-crossings, and we show how to apply this in particular cases. Though the methods of proof used are algebraic, we focus our discussion on the geometric significance and suggestiveness of results.
This talk is based on joint work with Scott Mullane and Paul Norbury.

Barbensi, Agnese. Topological Optimal Transport and Geometric Cycle Matchings
Speaker: Agnese Barbensi (The University of Queensland)
Time: 13:30 Thu 7 December
Place(s): 01-E215
Author(s): Agnese Barbensi, Stephen Y. Zhang, M. Stumpf

Topological data analysis has been demonstrated to be a powerful tool to describe topological signatures in real-life data, and to extract complex patterns arising in natural systems. An important challenge in topological data analysis is that of matching significant topological signals across distinct

systems. In geometry and probability theory, optimal transportation formalises notions of distance and matchings between distributions and structured objects. In this work, we propose a means of combining the two approaches to construct a mathematical formulation of a topological optimal transport theory. By building on recent adavancements in the domains of persistent homology, hypernetworks and optimal transportation theory, we develop a transport-based methodology for topological data processing. Our approach provides a unified framework for a transport model minimising topological distortion, while yielding a geometrically informed matching between persistent homology cycles.

Bokor Bleile, Yossi. Topology, geometry and microstructures
Speaker: Yossi Bokor Bleile (Aalborg University)
Time: 14:00 Thu 7 December
Place(s): 01-E215
Author(s): Yossi Bokor Bleile

Recently, tools from topology and geometry have led to insights about a variety of microstructures. In particular, persistent homology has helped materials scientists understand thermal-induced pore collapse in certain glasses. Similar techniques have enabled biophysicists to perform quantitative unbiased identification of sub-populations of human mesenchymal stem cells.
We will journey through these applications.

Burke, Rhuaidi. Developments in computational 4-manifold topology
Speaker: Rhuaidi Burke (The University of Queensland)
Time: 15:00 Tue 5 December
Place(s): 01-E215
Author(s): Rhuaidi Burke

Dimension 4 is the first dimension in which exotic smooth manifold pairs appear — manifolds which are topologically the same but for which there is no smooth deformation of one into the other. On the other hand, smooth and piecewise-linear manifolds (manifolds which can be described discretely) do coincide in dimension 4. Despite this, there has been comparatively little work done towards gaining an understanding of smooth 4-manifolds from the discrete and algorithmic perspective. In this talk, I will present some developments in this direction: a new software implementation of an algorithm to produce triangulations of 4-manifolds from handlebody diagrams, as well as a new heuristic for simplifying these triangulations. Using these new software tools, we present small triangulations of exotic 4-manifolds, and related objects.

Burton, Benjamin. Parallelism in topological algorithms
Speaker: Benjamin Burton (The University of Queensland)
Time: 16:30 Fri 8 December
Place(s): 01-E215
Author(s): Benjamin Burton

Nowadays the performance of computers is less about the speed of an individual task, and more about the number of cores that can be packed into a single machine—in other words, *parallel processing*. How can we harness the benefits of parallel processing for topological computing? In this talk we will discuss one of the fundamental algorithmic tools in knot theory and 3-manifold topology: *normal surface enumeration*, which has close links to polytope algorithms for convex hulls and vertex enumeration. In particular, we will outline different algorithmic frameworks for this problem and examine their potentials and pitfalls for parallelism.

Celoria, Daniele. A q-hypergeometric approach to the 3D index
Speaker: Daniele Celoria (The University of Melbourne)
Time: 16:00 Fri 8 December
Place(s): 01-E215
Author(s): Daniele Celoria

The 3D index is a q-series associated to ideal triangulations of 3-manifolds. In this talk we'll explore some unexpected interactions between the 3D index and q-hypergeometric series. This is part of a joint work with C. Hodgson and H. Rubinstein.

Coulter, Xavier. A one-parameter deformation of the monotone Hurwitz numbers
Speaker: Xavier Coulter (University of Auckland)
Time: 16:00 Wed 6 December
Place(s): 01-E215
Author(s): Xavier Coulter, Norm Do, Ellena Moskovsky

The monotone Hurwitz numbers are a family of numbers which arise in the study of integration on unitary groups. In recent joint work with Norm Do and Ellena Moskovsky, we introduce a one-parameter deformation of the monotone Hurwitz numbers and show that the resulting family of polynomials can be recovered from integration on complex Grassmannians. We will discuss this result and how it is obtained by adapting the Weingarten calculus for unitary groups

Garden, Grace. Character varieties and essential surfaces in arbitrary characteristic
Speaker: Grace Garden (The University of Sydney)
Time: 13:30 Wed 6 December
Place(s): 01-E215
Author(s): Grace Garden

In the seminal work of Culler and Shalen (1983), a method is outlined to detect essential surfaces in a three-manifold by studying their $SL_2(\mathbb{C})$-character variety. The method underscores connections between the theory of incompressible surfaces in three-manifolds, the geometry of representation varieties, and group actions on trees. In this talk, we lay a general foundation for this theory in arbitrary characteristic by using the same approach instead over $\mathbb{F}$, an algebraically closed field of positive characteristic. We apply the theory to a variety of settings.
This is joint work with Eric Chesebro, Ben Martin, and Stephan Tillmann.

Gover, Rod. Some progress on the ASD deformation complex
Speaker: Rod Gover (University of Auckland)
Time: 14:00 Fri 8 December
Place(s): 01-E215
Author(s): Rod Gover

A smooth, closed, oriented anti-self-dual four manifold is said to be unobstructed if the cokernel of the linearization of the self-dual Weyl tensor is trivial. This condition can also be characterized as the vanishing of the second cohomology group of the ASD deformation complex, and is central to understanding the local structure of the moduli space of ASD conformal structures. It also arises in construction of ASD manifolds by twistor and gluing methods. We give conformally invariant conditions which imply an ASD manifold of positive Yamabe type is unobstructed.
This is work with Matt Gursky

He, Alexander. The triangulation complexity of satellite knots
Speaker: Alexander He (The University of Queensland)
Time: 14:30 Wed 6 December
Place(s): 01-E215
Author(s): Benjamin A. Burton, Thiago de Paiva, Alexander He, Connie On Yu Hui

Problem 1.67 on Kirby's list asks: for a satellite knot K with companion C, is the crossing number of K greater than that of C? Surprisingly, this remains open in general. Given the beauty and utility of studying knots via the 3-manifolds given by their complements, it is natural to consider the following variant: for a satellite knot K with companion C, is the triangulation complexity of K greater than that of C? We show that the answer is "yes" at least when C is anannular (in particular, when C is hyperbolic).

Howie, Joshua. Free spanning surfaces which are not isotopic to state surfaces
Speaker: Joshua Howie (Monash University)
Time: 15:00 Fri 8 December
Place(s): 01-E215
Author(s): Joshua Howie

State surfaces are free spanning surfaces for knots which can tell us a lot about the geometry and topology of knot complements. We will discuss free spanning surfaces which do not arise from the state surface construction.

HUI, Connie On Yu. A complete classification of rod complements in the 3-torus
Speaker: Connie On Yu HUI (Monash University)
Time: 14:30 Tue 5 December
Place(s): 01-E215
Author(s): Connie On Yu HUI

Rod packings are used in crystallography to describe crystal structures with linear or zigzag chains of particles, and each rod packing can be topologically viewed as a collection of disjoint geodesics in the 3-torus. In a joint work with Jessica Purcell, we initiated the use of 3-dimensional geometry and tools from the 3-sphere to study the complements of rods in the 3-torus, and we partially classified the geometry of some families of rod complements in the 3-torus. In this talk, I will present a complete classification of the geometry of all rod complements in the 3-torus and an outline of the topological arguments. (Related preprints: https://arxiv.org/abs/2212.04662, https://arxiv.org/abs/2307.06317)

KOYAMA, MUSASHI. Reduced Vietoris Rips complexes: A faster way to compute PH_1
Speaker: MUSASHI KOYAMA (Australian National University)
Time: 16:30 Tue 5 December
Place(s): 01-E215
Author(s): MUSASHI KOYAMA

Vietoris-Rips persistent homology is one of the most commonly used types of persistent homology to analyse a point cloud. It has several benefits, such as being able to be computed for non-Euclidean metric spaces and not requiring any special structures to compute, such as the Delaunay triangulation. However, it suffers from having to analyse an enormous number of simplices, even for computing PH_1. In this talk we present a filtration of topological spaces which utilises a smaller number of simplices, but still gives the same persistent homology barcode as the standard standard Vietoris-Rips filtration.

Larusson, Finnur. Homotopy theory in the theory of minimal surfaces
Speaker: Finnur Larusson (The University of Adelaide)
Time: 15:00 Thu 7 December
Place(s): 01-E215
Author(s): Finnur Larusson

The Gauss map of a minimal surface in $\mathbb{R}^3$, parametrised as a conformal minimal immersion from an open Riemann surface M into $\mathbb{R}^3$, may be viewed as a meromorphic function on M. It is a long-standing open problem in the global theory of minimal surfaces to determine which meromorphic functions arise as the Gauss map of a *complete* minimal surface. In recent joint work with Antonio Alarcón (University of Granada, Spain), we took a new approach to this problem. We determined the homotopy type of the space of meromorphic functions that are the Gauss map of a complete minimal surface and showed that the inclusion of this space in the space of all meromorphic functions on M is a weak homotopy equivalence. Other related results will be briefly mentioned.

Madsen, Christian Degnbol. The Topological Properties of the Protein Universe
Speaker: Christian Degnbol Madsen (The University of Melbourne)
Time: 17:00 Tue 5 December
Place(s): 01-E215
Author(s): Christian D. Madsen, Agnese Barbensi, Stephen Y. Zhang, Lucy Ham, Alessia David, Douglas E.V. Pires, Michael P.H. Stumpf

Deep learning methods have revolutionized our ability to predict protein structures, allowing us a glimpse into the entire protein universe. As a result, our understanding of how protein structure drives function is now lagging behind our ability to determine and predict protein structure. Here, we describe how topology, the branch of mathematics concerned with qualitative properties of spatial structures, provides a lens through which we can identify fundamental organizing features across the known protein universe. We identify topological determinants that capture global features of the protein universe, such as domain architecture and binding sites. Additionally, our analysis also identified highly specific properties, so-called topological generators, that can be used to provide deeper insights into protein structure-function and evolutionary relationships. We used our approach to determine structural, functional and disease consequences of mutations, explain differences in properties of proteins in mesophiles and thermophiles, and the likely structural and functional consequences of polymorphisms in a protein. Overall, we present a practical methodology for mapping the topology of the known protein universe at scale.

Morgan, James. On the complexity of two-bridge link complements
Speaker: James Morgan (The University of Sydney)
Time: 15:00 Wed 6 December
Place(s): 01-E215
Author(s): James Morgan

The class of two-bridge links are known to possess a nice geometry in the sense that an ideal triangulation of their complements can be read directly from the link diagram. A certain infinite family of these triangulations, first studied by Sakuma and Weeks, have been shown to be minimal through volume bound arguments by Ishikawa and Nemoto. The complexity for the vast majority of these link complements, however, remains unknown.
In this talk we will briefly define the Sakuma-Weeks triangulations of two-bridge link complements and discuss recent progress on determining their complexity.
This is joint work with Jonathan Spreer.

Orseli, Marcos. Equivariant index on toric contact manifolds
Speaker: Marcos Orseli (The University of Adelaide)
Time: 13:30 Fri 8 December
Place(s): 01-E215
Author(s): Pedram Hekmati and Marcos Orseli

I will discuss the equivariant index of the horizontal Dolbeault operator on compact toric contact manifolds of Reeb type. This operator is transversally elliptic to the Reeb foliation and it features notably in calculations of partition functions of cohomologically twisted gauge theories. I will describe how to evaluate the index in general and give an explicit expression for it in terms of the moment cone. This is joint work with Pedram Hekmati.

Robertson, Marcy. Towers of Kashiwara-Vergne Solutions
Speaker: Marcy Robertson (The University of Melbourne)
Time: 14:30 Thu 7 December
Place(s): 01-E215
Author(s): Marcy Robertson

The motivating idea behind "Grothendieck-Teichmüller theory" is to study Galois actions on geometric spaces via the endomorphisms they induce on towers of fundamental groups of certain well-understood moduli spaces. The idea behind this talk is to import the fundamental aspects of this theory into the study of actions by the so-called "Kashiwara-Vergne groups" on free loop spaces.

Su, Lecheng. Alternating links on non-orientable surfaces
Speaker: Lecheng Su (Monash University)
Time: 14:00 Wed 6 December
Place(s): 01-E215
Author(s): Lecheng Su

Alternating links are a well-studied class of links which satisfy nice geometric and topological properties. There have been several old and recent results extending such properties to alternating links lying on closed orientable projection surfaces other than the 2-sphere. Less research has been done on how to extend to non-orientable projection surfaces, since they have only one side in an orientable 3-manifold. In this talk, I will define the notion of alternating links with a projection on non-orientable surfaces and introduce the generalized chunk decomposition as a combinatorial way of seeing the topology of such a link complement. Using this technique, I will show that an alternating link complement in a certain class of 3-manifolds is hyperbolic.

Thompson, Em. An algorithm to construct one-vertex triangulations of Heegaard splittings
Speaker: Em Thompson (Monash University)
Time: 13:30 Tue 5 December
Place(s): 01-E215
Author(s): Em Thompson

Jaco and Rubinstein introduced the notion of a layered triangulation of a 3-manifold in 2006. Such triangulations are one-vertex by construction, and Huszàr and Spreer later proved that they have bounded cut width, meaning they may be better suited as input for certain algorithms than triangulations with fewer tetrahedra. In this talk I will outline an algorithm to construct such a triangulation

from a Heegaard diagram and discuss some findings from preliminary computer searches. This is joint work with Alex He and James Morgan.

Thompson, Finn. Computing Heegaard Genus of 3-Manifolds
Speaker: Finn Thompson (The University of Queensland)
Time: 14:00 Tue 5 December
Place(s): 01-E215
Author(s): Benjamin A. Burton, Finn Thompson

The Heegaard genus of a 3-manifold is a topological invariant, calculated as the minimal genus of a surface that splits the manifold into two handlebodies. This is hard to determine theoretically, hence we aim to implement a theoretical algorithm of Hyam Rubinstein, particularly for hyperbolic 3-manifolds. We introduce a new tool that can simplify the set of almost normal surfaces of a triangulation to a set of normal surfaces, by modifying a particular tetrahedron of the triangulation.

Tillmann, Stephan. Slope norm, crosscap number and complexity of Dehn fillings
Speaker: Stephan Tillmann (The University of Sydney)
Time: 14:30 Fri 8 December
Place(s): 01-E215
Author(s): Bus Jaco, Hyam Rubinstein, Jonathan Spreer, Stephan Tillmann

I will report on joint work with Bus Jaco, Hyam Rubinstein and Jonathan Spreer. We describe an algorithm to compute smallest complexity surfaces spanned by boundary curves in any orientable, compact, irreducible 3-manifold M with incompressible boundary a torus. This is applied to give an algorithm to compute the crosscap number of a knot, and to give complexity bounds for 3-manifolds obtained from M by Dehn filling.

Tobin, Lucy. Vertex Numbers of 4-Manifold Triangulations
Speaker: Lucy Tobin (The University of Sydney)
Time: 16:00 Tue 5 December
Place(s): 01-E215
Author(s): Lucy Tobin

In this talk, we will ask a simple question about 4-manifold triangulations - what is the *largest* number of vertices possible for a triangulation of a given manifold with n pentachora? An accurate answer would immediately give us a lower bound on the complexity of the manifold, using some simple combinatorial observations and Dehn-Sommerville type relations. I will give a conjecture on the answer to this question and relate it to complexity, present an infinite series of many-vertex $\#^k\mathbb{CP}^2$ triangulations and discuss some heuristics for searching for counterexamples.
This is joint work with Jonathan Spreer.

Zymaris, Orion. Spinors and Descartes Theorem
Speaker: Orion Zymaris (Monash University)
Time: 17:00 Wed 6 December
Place(s): 01-E215
Author(s): Daniel Mathews and Orion Zymaris

Descartes' circle theorem relates the curvatures of four mutually externally tangent circles, three "petal" circles around the exterior of a central circle, forming a "3-flower" configuration. We generalise this theorem to the case of an "n-flower", consisting of n tangent circles around the exterior of a central circle, and give an explicit equation satisfied by their curvatures. The proof uses a spinorial description of horospheres in hyperbolic geometry.

Index of Speakers