WESTERN SYDNEY UNIVERSITY

Centre for Research in Mathematics and Data Science

CRMDS NEWSLETTER

Name Change

A proposal was approved to change the Centre name for the Centre for Research in Mathematics to the Centre for Research in Mathematics and Data Science. This Centre name was changed due to the evolution of the Centre since its establishment, as well as the growth of data science more broadly. In addition to this, the data science hub has recently been established within the Centre and by changing the Centre name, it will create a clean alignment clearly communicating the place to find data science expertise at Western.

Emeritus Professor Jon Berrick joins the Centre as an Adjunct

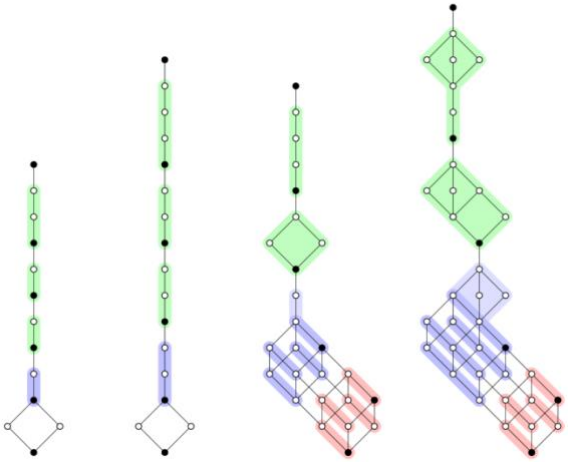
Emeritus Professor Jon Berrick held positions in mathematics at Oxford and Imperial College London prior to joining the National University of Singapore (NUS) in 1981. In 2012, he became the inaugural Professor of Science (Mathematics) at Yale-NUS College, serving as Head of Studies for Mathematical, Computational and Statistical Sciences, and facilitator for the Quantitative Reasoning course in the Common Curriculum. In 2014/15, he was the first moderator for Full Faculty Meetings, and then chaired the Committee on Integrity and Discipline. Along with his several books and over 70 research papers in mathematics, he has had research collaborations in neurophysiology, anatomy, and public health and safety, especially tobacco control – a subject in which he has been lecturing at Yale-NUS. For work on the mathematics of braids, Professor Berrick received Singapore's National Science Award in 2007. He has Honorary Professorships at University of Sydney and Western Sydney University, and is Editor-in-Chief of the Journal of the Australian Mathematical Society.

ARC Future Fellowship - Dr James East

Title: Diagram categories and transformation semigroups

Total awarded budget: $785,823

Project summary: A structural understanding of diagram categories is essential in many branches of mathematics and science. Despite this, very few methods for studying such categories are available, a fact this pure mathematics project seeks to rectify. By building strong bridges between diagram categories and semigroup theory, a field of abstract algebra that models transformation and change, the structure of diagram categories may be unlocked with powerful semigroup tools developed by the applicant investigator. Diagrammatic insights will also yield new ways to study semigroups,



and the many other mathematical structures they interact with. Outcomes will have a lasting impact on both theories as well as the many fields influenced by them.

Biography

James obtained his PhD in pure mathematics from the University of Sydney, where he also did his BSc (Adv Math), gaining first class honours and the university medal. Since then, he has held postdoctoral research positions at La Trobe University and the University of Sydney, before joining Western Sydney University in 2011. He is currently a senior lecturer and ARC Future Fellow.

His research comes under the broad headings of abstract algebra and combinatorics, and his particularly interested in semigroup theory. The main objects of his study is the transformation semigroups, diagram monoids (and associated algebras and categories), and braid groups and monoids. Recurring themes in his work include presentations, congruences, (products of) idempotents, sandwich semigroups, combinatorial invariant theory and more.

Outside of mathematical research, He enjoys philosophy, cricket, Rubiks puzzles, and a single malt whisky. *This information has been contributed by Doctor East.*

New Data Scientist Joins CRMDS – Dr Rosalind Wang

Dr Rosalind Wang (pictured Left) joined CRMDS as a senior lecturer in Data Science in Nov 2019. Her main research interest is classification and feature selection.

Rosalind currently applies her works in two main areas: astronomy and health diagnosis. Engineer by training, Rosalind still believes one should multiple one's estimate by a safety factor of 2.5.

Rosalind loves singing, and as a member of the Macquarie Singers, she has performed in the Sydney Opera House many times.

However, with a toddler in the house, there's rarely any time for singing, drawing, piano, opera or books any more.

What spare time she does get these days are spent walking in the bush and going on bear hunts. Rosalind wishes she can visit the Clangers' Planet one day and find out whether it's bigger on the inside.

Annual Meeting of the Australian Mathematical Society

Associate Professor Leanne Rylands was the first ever Invited Speaker from Western Sydney University at the Annual Meeting of the Australian Mathematical Society which was held at Monash University in December 2019.

She presented a very interesting and eye opening talk entitled "The mathematics problem or falling standards of Australian mathematics".

Mathematical and Computational Evolutionary Biology Meeting

Theme*: "Towards better trade-offs between speed and accuracy for the analysis of very large data sets in evolutionary biology"*

Professor Andrew Francis (pictured Left) was a keynote speaker at this meeting: http://www.lirmm.fr/mceb2019/, with all expenses paid by the Pasteur Institute in Paris. They also supported him to visit them at the Pasteur for a week to give a talk and do some research with them. Andrew's Keynote Address was **The Mathematics of Phylogenetics Networks.**

New Publication

Dr James East and Professor Nik Ruškuc. "Congruence lattices of ideals in categories and (partial) semigroups".

A preprint is available here: https://arxiv.org/abs/2001.01909

Nik is a professor of Mathematics in the School of Mathematics and Statistics at the University of St Andrews and has an EPSRC grant that provides funding specifically for several visits to WSU, and the paper came out of his visit in January 2019. The paper builds on ideas from their earlier paper:

James East, James Mitchell, Nik Ruškuc and Michael Torpey. "Congruence lattices of finite diagram monoids". Adv. Math. 333 (2018), 931–1003.

The new paper extends these ideas to categories and their ideals; it develops a general theory, and then applies it to many examples including transformation, partition, Brauer, Temperley-Lieb, Jones and partial braid categories.

According to James it really has been an honour to publish a paper in Memoirs of the AMS. "Unless I'm mistaken, the last semigroups paper in the journal was published in 1978, so this is the only one in my lifetime!"

PhD Completions

Michael Hendriksen (pictured below) a PhD candidate from the Centre has accepted a Postdoctoral Fellowship in Dusseldorf after submitting his PhD thesis in November 2019,

"Barking up the wrong tree: Some obstacles to phylogenetic reconstruction"

Abstract:

Phylogenetics is the study of evolutionary relationships between entities, usually biological in nature. The primary aim of such study is to elucidate the structure of these evolutionary histories. Unfortunately, such study can run into a variety of obstacles, both practical and theoretical. In this thesis we explore theoretical obstacles to phylogenetic reconstruction, by examining several scenarios in which distinguishing between similar structures can become quite difficult.

In Chapter 2, we consider when metrics on trees and metrics on networks can become indistinguishable, and present several novel results in this area, showing that it is possible for any tree metric to be represented on a non-trivial network, and provide early results on the possible structures of these networks.

In Chapter 3, we consider tree-based networks — a phenomenon in which networks have a strong tree-like signal. We present the first findings on these networks in the context of unrooted non-binary networks. We characterise the circumstances under which such networks can become 'saturated' by these signals, and provide some graph theoretical results in this area as well.

In Chapter 4 we consider the scenario in which two trees can appear similar due to their hierarchical structure. We present a new metric to quantify this similarity, and use simulations to show several promising properties of the metric and the relative accuracy of a function that gives an upper bound to the metric.

Chapter 3 is largely based on the article "Tree-based unrooted nonbinary phylogenetic networks", written by myself and published in Mathematical Biosciences, Volume 302, August 2018, Pages 131-138. Chapters 2 and 4 are based on two papers currently submitted to journals, authored by myself and my supervisor, Professor Andrew Francis. The remainder of this thesis is, unless otherwise indicated, my own work.

CRMDS PhD Graduate on the front line of COVID -19 Research

Dr Sangeeta Bhatia (pictured left), a recent PhD graduate of the Centre for Research in Mathematics and Data Science is currently completing a postdoctoral Fellowship at the Imperial College London.

In pre COVID-19 times, I worked mostly on modelling the spatial spread of Ebola and was part of the Ebola outbreak response team at Imperial, providing inputs to the World Health Organisation.

Since January 2020, She has been a part of the Imperial College COVID-19 response team. The team is engaged in providing modelling inputs to the UK government and other academic and health partners.

A couple of key projects that she is leading are producing weekly forecasts of the trajectory of the pandemic in various countries, estimation of key epidemiological quantities (e.g. the serial interval which is the time between onset of symptoms in a primary case and their secondary case), and reviewing evidence of disease progression in children.

5 Years of Maths in Action

In September 2019 a 110 students from some of the high schools in Western Sydney attended the fifth year of Maths in Actions in Penrith.

As an observer in the last 5 years this year the students looked much more attentive and more absorbed in the talks, asking questions and taking parts in the activities.

Dr Stephen Weissenhofer (*pictured right*) opened the day by telling students how vital mathematics is and then continued by a talk on probability, proving there live at the stage that one needs only 23 people to have 50% chance that two were born in the same day and month (if I understood it correctly!)

A/Prof Leanne Rylands (*pictured left)* showed us how to think about Rubik cubes and got students to try out the approach, also hinted to how one can give a group theory interpretation to the puzzle.

Dr James East presented his infinity talk. He proved that infinity^infinity is larger than infinity but managed to avoid any theological blasphemy in the interpretation of the result.

Michael Hendriksen talked about juggling and how one can use maths to describe different ways one can juggle balls. He managed to juggle up to 6 balls and received applause from high school students which is not easy to get these days.

Dr Anton Bogdanovych talked about how mathematics is the main tool to create computer games and to enable a robot's movements and demonstrated that by the school's robot who performed some rap moves.

CRMDS Abend Seminars

CRMDS has initiated Zoom talks which will be held on Thursdays 8pm Sydney Time: (UTC 10am). An average of 60 participants from around the globe take part in the seminars. Topics can be found at: *https://www.westernsydney.edu.au/crm/colloquia*

Publications

2019:

1. **James East.** Idempotents and one-sided units in infinite partial Brauer monoids. Journal of Algebra 534: 427–482, 2019.
2. Ying-Ying Feng, Asawer Al-Aadhami, Igor Dolinka, **James East,** Victoria Gould.Presentations for singular wreath products. J. Pure Appl. Algebra 223: 5106–5146, 2019.
3. **James East,** Ron Niles. Integer triangles of given perimeter: A new approach via group theory. Amer. Math. Monthly 126(8): 735–739, 2019.
4. **James East,** Ron Niles. Integer polygons of given perimeter. Bull. Aust. Math. Soc. 100: 131–147, 2019.
5. **James East,** The n-matchstick challenge accepted. Aust. Math. Soc. Gaz. 46(5): 285–287, 2019.
6. **James East,** Maximilien Gadouleau, James D. Mitchell. Structural aspects of semigroups based on digraphs. Algebr. Comb. 2(5): 711–733, 2019.
7. Igor Dolinka, **James East,** Athanasios Evangelou, Des FitzGerald, Nicholas Ham, James Hyde, Nicholas Loughlin, James D. Mitchell. Enumeration of idempotents in planar diagram monoids. J. Algebra, 522: 351–385, 2019.
8. **James East,** Attila Egri-Nagy, James D. Mitchell, Yann Presse. Computing finite semigroups. J. Symbolic Comput., 92: 110–155, 2019.
9. **James East,** Presentations for rook partition monoids and algebras and their singular ideals. J. Pure Appl. Algebra, 223(3): 1097–1122, 2019
10. **Chad Clark**, Attila Egri-Nagy, **Andrew R. Francis**, **Volker Gebhardt**, Bacterial phylogeny in the Cayley graph, Discrete Mathematics, Algorithms and Applications, Vol. 11, No. 05, 1950059 (2019).
11. María Cumplido, **Volker Gebhardt**, Juan González-Meneses, Bert Wiest: On parabolic subgroups of Artin-Tits groups of spherical type. Adv. Math. 352 (2019), 572-610.
12. **Michael Hendriksen** and **Andrew Francis**, Tree-metrizable HGT networks, Mathematical Biosciences, Volume 318, December 2019, 108283.
13. Guajardo MGU, Kelly C, Bond K, **Thomson R,** Slewa-Younan S. An evaluation of the teen and Youth Mental Health First Aid training with a CALD focus: an uncontrolled pilot study with adolescents and adults in Australia. International Journal of Mental Health Systems 13 (1), 73
14. **Thomson, R. J.,** McMorran, B., Hoy, W., Jose, M., Whittock, L., Thornton, T., … Foote, S. (2019). New Genetic Loci Associated with Chronic Kidney Disease in an Indigenous Australian Population. Frontiers in genetics, 10, 330. doi:10.3389/fgene.2019.00330
15. Strain, E., Edgar, G., Ceccarelli, D., Stuart-Smith, R., Hosack, G., & **Thomson, R**. A global assessment of the direct and indirect benefits of marine protected areas for coral reef conservation. Diversity and Distributions, 25(1), 9-20. (Editor's Choice)
16. Chauhan G et. al. (**Thomson R** is author 130 out of 150 authors). Genetic and lifestyle risk factors for MRI-defined brain infarcts in a population-based setting. Neurology Jan 2019, 92 (5) e486-e503; DOI: 10.1212/WNL.0000000000000685
17. Atwa, S., Gauci-Mansour, V.J., **Thomson, R.,** Hegazi, I. Team-based and case-based learning: a hybrid pedagogy model enhancing students' academic performance and experiences at first-year tertiary level. Aust. Educ. Res. (2019) 46: 93. https://doi.org/10.1007/s13384-018-0282-y 2020:
18. **LAF Park**, **Y Guo,** J Read, Assessing the Multi-labelness of Multi-label Data, Joint European Conference on Machine Learning and Knowledge Discovery in Databases 2019

19. NO Ralph, RP Norris, G Fang, **LAF Park**, TJ Galvin, MJ Alger, ...Radio galaxy zoo: Unsupervised clustering of convolutionally auto-encoded radio-astronomical images, Publications of the Astronomical Society of the Pacific 131 (1004), 108011, 2019
20. KJ Luken, RP Norris, **LAF Park** Preliminary Results of Using k-nearest-neighbor Regression to Estimate the Redshift of Radio-selected Data Sets, Publications of the Astronomical Society of the Pacific 131 (1004), 108003, 2019
21. R Lovell, D Scott, **L Park**, Soccer Velocity Thresholds: Do we really know what's best? Science and Medicine in Football 3 (1), 85-86, 2019
22. **LAF Park,** D Scott, R Lovell, Velocity zone classification in elite women's football: where do we draw the lines? Science and Medicine in Football 3 (1), 21-28, 2019

2020:

1. Chongrong Fang, Yifei Qi, Peng Cheng and **Wei Xing Zheng**, Optimal periodic watermarking schedule for replay attack detection in cyber-physical systems. Automatica, Vol. 112, Article 108698 (13 pages), 2020. DOI: 10.1016/j.automatica.2019.108698, REDI ID: 260360.
2. Mareike Fischer and **Andrew Francis**, The space of tree-based phylogenetic networks, *Bulletin of Mathematical Biology*, in press.
3. Mareike Fischer and **Andrew Francis,** How tree-based is my network? Proximity measures for unrooted phylogenetic networks, *Discrete Applied Mathematics*, in press.
4. **Andrew Francis** and Henry Wynn, A mean first passage time genome rearrangement distance, *Journal of Mathematical Biology*, in press.
5. **Volker Gebhardt**, Stephen Tawn: Enumerating unlabelled lattices. J. Algebra 545 (2020), 213-236.
6. **Yi Guo**, Stephen Tierney, Junbin Gao, Robust Functional Manifold Clustering, IEEE Transactions on Neural Networks and Learning Systems, 2020 [pdf][code]
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8. R. Zach Aandahl, Sangeeta Bhatia, Natalia Vaudagnotto, Arthur G. Street, **Andrew R. Francis**, Mark M. Tanaka, MERCAT: computational tools for analysing and visualising molecular data from bacterial isolates, *Infection, Genetics and Evolution*, Volume 77, January 2020, 104043.
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10. Junjie Yang, **Yi Guo,** Zuyang Yang, Liu Yang, Shengli Xie, Estimating Number of Speakers via Density-Based Clustering and Classification Decision, IEEE Access, Vol 7, 2019[pdf][code]
11. Junjie Yang, **Yi Guo**, Zuyang Yang, Member, Shengli Xie, Under-determined Convolutive Blind Source Separation Combining Density-based Clustering and Sparse Reconstruction in Time-Frequency Domain, IEEE Transactions on Circuits and Systems I, 2019[pdf]
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14. Dianhao Zheng, Hongbin Zhang, Jian Zhang, **Wei Xing Zheng** and Steven W. Su, Stability of asynchronous switched systems with sequence-based average dwell time approaches. Journal of The Franklin Institute, Vol. 357, No. 4, pp. 2149-2166, 2020. DOI: 10.1016/j.jfranklin.2019.11.067, REDI ID: 260804.
15. Yuhua Cheng, Lei Shi, Jinliang Shao and **Wei Xing Zheng**, Sampled-data scaled group consensus for second-order multi-agent systems with switching topologies and random link failures. Journal of The Franklin Institute, Vol. 357, No. 5, pp. 2868-2881, 2020. DOI: 10.1016/j.jfranklin.2019.11.041.
16. Ning Li and **Wei Xing Zheng**, Bipartite synchronization for inertia memristor-based neural networks on coopetition networks. Neural Networks, Vol. 124, pp. 39-49, 2020. DOI: 10.1016/j.neunet.2019.11.010, REDI ID: 260380.
17. Jiankun Sun, Jun Yang, Shihua Li and **Wei Xing Zheng**, Output-based dynamic event-triggered mechanisms for disturbance rejection control of networked nonlinear systems. IEEE Transactions on Cybernetics, Vol. 50, No. 5, pp. 1978-1988, 2020. DOI: 10.1109/TCYB.2018.2877413, REDI ID: 256348.
18. Peng Liu, **Wei Xing Zheng** and Zhigang Zeng, On complete stability of recurrent neural networks with time-varying delays and general piecewise linear activation functions. IEEE Transactions on Cybernetics, Vol. 50, No. 5, pp. 2249-2263, 2020. DOI: 10.1109/TCYB.2018.2884836, REDI ID: 256483.
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20. Weiming Fu, Jiahu Qin, Yang Shi, **Wei Xing Zheng** and Yu Kang, Resilient consensus of discrete-time complex cyber-physical networks under deception attacks. IEEE Transactions on Industrial Informatics, Special Section on Resilience, Reliability, and Security in Cyber-Physical Systems, Vol. 16, No. 7, pp. 4868-4877, 2020. DOI: 10.1109/TII.2019.2933596.
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22. Yanpeng Guan, Guonan Ping, **Wei Xing Zheng** and Huijuan Yao, Distributed event-triggered scheduling in networked interconnected systems with sparse connections. Neurocomputing, Vol. 400, pp. 420-428, 2020. DOI: 10.1016/j.neucom.2019.04.080, REDI ID: 257099.
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26. Francis A, Guo Y, Hurley P, Obst O, Park LAF, Tanaka M, **Thomson R**, Wang R. Projected ICU and Mortuary load due to COVID-19 in Sydney. *medRxiv* doi: https://doi.org/10.1101/2020.03.31.20049312

Conference Papers

- Junjie Yang, **Yi Guo**, Zuyun Yang, Chao Yang, A sparsity-relaxed algorithm for the under-determined convolutive blind source separation, 2nd International Conference on Image and Video Processing, and Artificial Intelligence, IVPAI 2019 [pdf]
- Laurence Park, **Yi Guo,** Jesse Read, Assessing the multi-labelness of multi-label data, ECML, 2019
- Kingshuk Mazumdar, Dongmo Zhang, **Yi Guo**, Multi-peak algorithmic trading strategies using Grey Wolf Optimizer, PRICAI, 2019
- Kingshuk Mazumdar, Dongmo Zhang, **Yi Guo**, Portfolio Risk Optimisation and Diversification using Swarm Intelligence, PRICAI, 2019
- Abdesselam Bouzerdoum, Philip B. Chapple, Mark Dras, **Yi Guo**, Len Hamey, Tahereh Hassanzadeh, Thanh Hoang Le, Omid Mohamad Nezami, Mehmet Orgun, Son Lam Phung, Christian Ritz, Maryam Shahpasand, Improved Deep-Learning-Based Classification of Mine-Like Contacts in Sonar Images from Autonomous Underwater Vehicles", Proc. Underwater Acoustics Conference and Exhibition (UACE), 2019

New PhD Candidate: Dai Shi, starting from 6/4/2020 on topics in computational geometry

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